NATURE

No. 4169 SATURDAY, SEPTEMBER 24, 1949 Vol. 164

CONTENTS

	Page
Science and Telepathy	505
Logic and Science. By Prof. Herbert Dingle	506
General European History. By Prof. T. H. Marshall	507
American Chemical Industry in the Twenties	507
Electron and Nuclear Physics. By S. Weintroub	508
Photography in Forensic Science. By Dr. H. J. Walls	508
Grassland Farming and Food in Britain. By W. D. Brind	509
Ivan Petrovich Pavlov (1849–1936). By Prof. B. P. Babkin	510
The Ionosphere and the Propagation of Radio Waves. By Dr. J. A. Ratcliffe, O.B.E.	511
Physiological and Psychological Effects of High Temperature and Humidity in Mining and Metallurgical Works. By D. B.	513
New Materials and their Engineering Significance	514
Obituaries:	
Prof. P. E. Newberry, O.B.E. By Prof. Battiscombe Gunn, F.B.A.	517
Dr. James Colvin	518
News and Views	518
Physical Approach to the Study of Biological Systems. By Prof. J. T. Randall, F.R.S.	521
Preparation and Insecticidal Action of *bis*(*bis*-Dimethylamino)-Phosphonous Anhydride. By W. A. L. David and B. A. Kilby	522
Progress of Cancer Research. By D. A. G. Galton, I. Hieger and L. F. Lamerton	523
Institution of Electronics (N.W. Branch): Fourth Annual Exhibition. By H. Steeple	525
Objectives in the Education of Colonial Peoples	526
German Timber Industry during 1939–45	527
Letters to the Editors:	
Absorption Spectra, Molecular Weights and Visual Purple.—Dr. F. D. Collins and Prof. R. A. Morton	528
Species Differences in Insulins.—Dr. F. Sanger	529
Primary Site of the Action of Cobalt in Ruminants.—Dr. Hedley R. Marston, F.R.S., and H. John Lee	529
Toxicity of Polar Bear Liver.—Dr. Kaare Rodahl	530
Hypervitaminosis A and Scurvy.—Dr. Kaare Rodahl	530
Ascorbic Acid Content of Some Local Barbados Foods.—J. B. D. Robinson and Joan M. Parry	531
Ultra-Violet Absorption of Living Cells.—J. R. G. Bradfield and Dr. M. Errera	532
Alternaric Acid, a Biologically Active Metabolic Product of the Fungus *Alternaria solani*.—Dr. P. W. Brian, P. J. Curtis, H. G. Hemming, C. H. Unwin and Joyce M. Wright	534
Synthesis of Cinerone, Cinerolone and of Cinerin-I.—L. Crombie and Dr. S. H. Harper	534
Dimensions and Intrinsic Viscosity of Coiled Chain Molecules in Solution.—E. D. Kunst	535
A Method of Breaking Emulsions.—Dr. A. S. C. Lawrence, D. Barby and O. S. Mills	536
Surface Effect and Structure of Single Crystal Wires.—Prof. E. N. da C. Andrade, F.R.S.	536
Effect of Small Quantities of Hydrogen and Grain-Size on the α-β Transformation of Titanium.—A. D. McQuillan	537
Colour Changes Induced in Molybdenum and Tungsten Oxides under Flame Impact.—J. R. Arthur	537
Absence of Angular Correlation between β- and γ-Rays in Allowed β-Transitions.—M. A. Grace, R. A. Allen and Dr. H. Halban	538
Electron Pair Creation by a Spherically Symmetrical Field.—Dr. S. Devons and G. R. Lindsey	539
Reversibility of Oxygen Poisoning in Oxide-Cathode Valves.—Dr. G. H. Metson	540
Rheological Properties of High-Viscosity Solutions of Long Molecules.—Prof. F. H. Garner, O.B.E., and Dr. Alfred H. Nissan	541
Use of Geiger Counter for Quantitative Estimation of Phosphorus-32 in Histological Sections.—H. F. Atkinson	541
Transpiration into a Saturated Atmosphere.—Prof. D. Thoday, F.R.S.	541
Production of Spring Wood with β-Indole Acetic Acid (Hetero-auxin).—D. A. Fraser	542
Occurrence of *Falkenbergia* on the English Coast.—Mrs. C. C. Harvey and Dr. Kathleen M. Drew	542
Germination of Zygospores in *Chlamydomonas*.—Ralph A. Lewin	543
Effect of Ethyl Alcohol and Carbon Dioxide on the Sporulation of Bakers' Yeast.—T. B. Bright, P. A. Dixon and J. W. T. Whymper	544
Automatic Measuring Burette.—E. F. Collingwood	544
A Simple Automatic Fraction-Cutter for Liquid Columns.—D. M. P. Phillips	545
A Pressure-Cooked Non-Moulding Adhesive Flour Paste.—Lindsay Verrier	545
Recent Scientific and Technical Books	Supp. iv

SCIENCE AND TELEPATHY

IN his presidential address to Section D (Zoology) of the British Association at Newcastle recently, Prof. A. C. Hardy put forward the tentative suggestion that one factor in moulding patterns of behaviour among the members of a given species might be something akin to what is usually called telepathy, a phenomenon which he considered had now been established and which was clearly a revolutionary discovery from whatever point of view it might be regarded. Although, perhaps, a little apologetic in advancing this idea, Prof. Hardy did not conceal his belief that few could reject the evidence for telepathy were they to examine it with unbiased minds and without undue prejudice.

It is interesting to recall that the same problem was met by Freud when, in 1922, he was driven to suspect that elements suggesting telepathy were beginning to intrude in dream analysis. Some ten years later, when the evidence for this intrusion seemed better authenticated, he pointed out that it was futile to conceal the fact that any consideration of telepathy was rendered particularly hard on account of the intellectual, psychological and historical factors involved. Prejudices, although often useful, could sometimes be harmful and obstructive, and although a good deal of excuse could be found for those who nourished them in the case of occult phenomena, it was possible that, under what Freud rightly termed the veil of fraud and phantasy, there lay a hard core of facts, hitherto mostly unrecognized and, even when suspected as existent, not even dimly understood. The study of such matters has, as he rightly pointed out, become a highly specialized and difficult pursuit which the ordinary scientific man cannot hope to follow while at the same time pursuing his own interests and investigations.

Although inquiries into cases of alleged telepathic phenomena have been going on for many years, the majority of the cases reported have been of the spontaneous variety which, impressive at first sight, have been found to be extremely difficult to appraise at their true evidential value. So early as 1885, the Society for Psychical Research had foreseen the gradual emergence of a statistical technique for dealing with the material on a better experimental basis; and recent years have, as Prof. Hardy indicated, shown a marked improvement in devising fresh tests and controls under the direction of such workers as R. A. Fisher, W. L. Stevens, Whately Carington and S. G. Soal in Great Britain, and J. B. Rhine and his co-workers in the United States.

As might have been expected in so complex and exasperating a subject, progress has been uneven, and some of the published results open to grave doubts. But an enormous amount of patient work has been done; it is noteworthy that many of the earlier criticisms have had to be abandoned, and in some cases those critics who hoped to discover easily detected flaws in the technique have found that their objections had already been foreseen and countered by the investigators. Indeed, another zoologist, Prof. Evelyn Hutchinson of Yale, after examining the

conditions of the well-known Soal–Goldney experiment (*Proc. Soc. Psych. Research*, Dec. 1943), pointed out in the *American Scientist* of April 1948 that one moral to be derived from that piece of research was that many workers in ordinary science lived in glass houses and should not, therefore, throw stones.

As a result of the recent work on telepathy mentioned by Prof. Hardy, public interest in the subject has been re-awakened. This, unfortunately, has led to a wave of popular credulity which has become somewhat disturbing to workers in psychical research, since it has affected persons of education and even scientific standing in their own particular fields. This attitude on the part of the public has been partly due to the highly publicized 'telepathic' performances of two radio entertainers from Australia, who have done for British radio what Dunninger and his co-performers have been doing for some time in the United States. Moreover, the producer of the show was allowed to publish some paragraphs in the *Radio Times* in which he categorically stated that there had not been any 'faking', an individual opinion to which he was clearly entitled, but which some might consider to be gravely misleading to the general public, as the honorary secretary of the Occult Committee of the Magic Circle pointed out with great cogency in a subsequent issue. Amid the acute controversy that followed, the entertainers themselves quite properly left the decision to the judges. They made no claims, and indeed could scarcely have done so with impunity, so stern is the professional disapproval of any performers who invoke a 'supernormal' element in their mystery acts. However, in spite of the repeated assurances of both psychical researchers and magicians regarding the entirely normal and natural means by which these stage and radio 'telepathic' effects are achieved, many have apparently continued to believe that telepathy can be demonstrated to order by certain gifted persons, and used for the purposes of entertainment.

It might have been supposed that the real nature of a mystery show on the Light Programme of the British Broadcasting Corporation could scarcely have been misunderstood; yet it is clear that the popular imagination, stimulated and prepared, perhaps, by the more sensational accounts in the Press of the results of serious inquiries, has not been slow to see in a radio 'turn' an example of telepathy in action. Similarly, certain psycho-analysts and psychiatrists are apt to think that they see examples of it in their consulting rooms, whereas in many cases these incidents would fail to attract even the passing interest of the psychical researcher with real experience of the subject. What is clear at the present time, however, is that a deep distinction should be drawn between the patient and laborious experiments such as those to which Prof. Hardy referred, and the clever and ingenious variety acts, in which the concept of 'telepathy' is used in the advertising 'build-up' in order to add increasing mystery to the entertainment, and to confuse those who have never taken the trouble to make themselves acquainted with the means through which the possibly genuine may be distinguished from the almost certainly spurious.

LOGIC AND SCIENCE

The Limits of Science

Outline of Logic and of the Methodology of the Exact Sciences. By the late Dr. Leon Chwistek. Translated from the Polish by Helen Charlotte Brodie and Dr. Arthur P. Coleman. (International Library of Psychology, Philosophy and Scientific Method.) Pp. lvii + 347. (London: Kegan Paul and Co., Ltd., 1948.) 30*s*. net.

IT was probably the discovery of non-Euclidean geometry that awakened the desire to abandon intuition as the basis of science and to confine consideration to the manipulation of symbols operating according to certain defined rules. Throughout the nineteenth century steady, though slow and inconspicuous, progress in this endeavour was made; but a sharp acceleration occurred at the beginning of the twentieth century from two independent causes. First, the theory of relativity revealed the dangers lying unsuspected in such intuitions as that of a unique, universal time scale, for example; secondly, the publication of Whitehead and Russell's "Principia Mathematica" showed a vision of a logical machinery by means of which scientific discoveries might be placed on an unassailable axiomatic basis and developed without fear of contradiction. Subsequent developments have not proceeded as smoothly as might have been expected, but nevertheless the prospect opened up has attracted some of the acutest minds of our generation, and the quest has grown from a harmless eccentricity into one of the most active and important movements in modern philosophy.

The late Dr. Chwistek's book is fundamentally an attempt to formulate a set of axioms and rules of manipulation adequate for the needs of science and philosophy. It is evidently the product of a powerful mind, equipped with wide reading and the fruits of many years concentration on logical questions. Those who are engaged in a like endeavour cannot afford to ignore this attempt to solve their problems.

Unfortunately, however, among Dr. Chwistek's gifts that of being intelligible was not included. The connexion between one sentence and the next is sometimes impossible to discover and at others is ultimately found to proceed from a quite minor connotation of the former. Reading the book is like reading a modern introspective novel, with the added annoyance that one really wants to know what Dr. Chwistek is trying to say. This is not the fault of the translators, who—especially Miss Brodie—have made heroic efforts on the reader's behalf. Before Chwistek's "Introduction" she has given an "Introduction" of her own of 37 pages embellished with 101 footnotes and supplemented by an "Appendix" of 31 pages. There is a "Preface" to this "Introduction", preceded by a "Translators' Preface" and an "Author's Preface to English Edition". Further, there is a bibliography of Chwistek's works, an index of symbols and name and author indexes, making altogether 111 pages of elucidation of 292 pages of text. Alas, that such industry should avail so little! The basis of Chwistek's system is the idea of "sound reason", but "unfortunately", says Dr. Brodie, "it is difficult to discover exactly what Chwistek means by sound reason". It has to be supplemented by "logic", but "he uses the term 'logic' in two distinct senses which he himself does not carefully differentiate". And so we proceed. The work itself only

too faithfully confirms the comment. In the circumstances I have felt that my duty as a reviewer falls short of devoting the remainder of a lifetime to wooing so unresponsive a text. I can therefore express no opinion on the soundness of the system; I can only indicate what a rich field lies open to the logician in want of a subject for analysis.

Nevertheless, the book is well worth reading. As a source of fruitful suggestions, of pregnant sentences and of directions to discussions—particularly Polish—which one might otherwise have missed, it is to be highly recommended. On what grounds its title was chosen I have not discovered. As with most writers on these subjects, there is evident a lack of familiarity with the actual practice of scientific workers and a looseness of thinking on scientific questions that contrasts strangely with the rigour of their thinking in pure symbolic logic. For example, because it is possible to adopt a scale of velocities which has no upper limit, Chwistek concludes that "the legend according to which there is no velocity greater than that of light is disproved" (p. 247); he overlooks the fact that on this scale the velocity of light is infinite. Again, his conclusion that "all modern arguments which seem to overthrow the doctrine of determinism appear to be illusory" (p. 254) demands a metaphysical definition of determinism which he professes to avoid. Perhaps the chief contribution of the book to science is contained in the remark on p. 253: "Thus a profound relation between events which never can be foreseen and undecidable propositions has been established".

The translators might note that the plural of formula is not formuli and that 'data' takes a plural verb.

HERBERT DINGLE

GENERAL EUROPEAN HISTORY

Chapters in Western Civilization

Selected and edited by the Contemporary Civilization Staff of Columbia College, Columbia University. Vol. 1. Pp. ix+438. Vol. 2. Pp. ix+300. (New York: Columbia University Press; London: Oxford University Press, 1948.) 14*s*. net each Vol.

THESE two volumes have been produced for students following a course in "Contemporary Civilization" at Columbia College. They provide, in conjunction with a basic source book, the historical background. It is natural that the first volume, going down to the French Revolution, should give the story of civilization in Western Europe; it is curious that the second volume should stick so closely to the same theme, having little more than passing references to civilization in the United States. The final chapter, for example, is entitled "Europe between World Wars". One can only conclude that America between world wars is dealt with in the lecture course, and hope that sufficient attention is paid to the way in which civilization is transmogrified when it is transplanted. "Background", in fact, is not a very happy metaphor by which to refer to the evolution of culture prior to its diffusion.

About half the chapters were specially written for the course or for this book; the rest are taken from recently published works. This method of compilation leads to some looseness of structure, marked differences of treatment, and occasional overlaps and omissions. But, considering the diverse origins of the contributions, the volumes present a fairly coherent plan. The main emphasis is on the mind, rather than the structure, of society, though this is less true of the first few chapters than of what follows. Medieval social systems are described and analysed with considerable skill—which is not surprising, since medieval historians have practised sociology with conspicuous success for at least half a century. The modern historians represented here—and this is true to a great extent of others as well—tend to divide the subject into events and ideas. The chapters on events are unequal, some sinking to a low level of disjointed cataloguing. The chapters on ideas reveal in most cases a serious attempt to let students into the world of thought, rather than to leave them battering in vain against a hedge of names, titles and set phrases indicative of 'schools' and their theories; and the range of ideas treated is wide. Political theory naturally bulks large; but religion, and not merely church history, is fully treated, philosophy gets a fair share of attention, and science is recognized as a worthy companion of the rest. This last is a welcome feature of the book, since humanists are capable sometimes of forgetting that science (other than as applied to manufacturing techniques) is a major part of civilization, and still more that some knowledge of it and its history should be included in the general education of a man of culture.

But should such a book be written at all? It is scarcely possible to answer the question without fuller knowledge of the way it is used by the lecturers in the course. Taken by itself, it is not wholly satisfactory either as a substitute for other reading or as a stimulant and guide to it. It is too long to give an enlightening conspectus into which fresh knowledge can be welded when it is acquired from other sources, and too short to tell the intelligent undergraduate everything he wants to know. To take one example, what is the precise function of a history of the French Revolution in fifty pages, however well written, unless it is part of an interpretation of eighteenth- and nineteenth-century history offered by a single philosophic mind? The multiplicity of authors makes such unity impossible; but perhaps the subject is in any event too vast. One can study a single aspect of a long period, or all aspects of a short period, but not all aspects of a long period—at least not within the compass of one book.

T. H. MARSHALL

AMERICAN CHEMICAL INDUSTRY IN THE TWENTIES

American Chemical Industry

The Merger Era. By Williams Haynes. Vol. 4, 1923–1929. Pp. xli+638+46 plates. (New York: D. Van Nostrand Co., Inc.; London: Macmillan and Co., Ltd., 1948.) 55*s*. net.

IT was a huge task which Williams Haynes undertook when he conceived a history of American chemical industry from the year 1608 to the present time, to appear in six volumes. The first volume has yet to come. Volumes 2 and 3 appeared in 1946, and in 1948 the fourth volume has arrived—an extraordinary achievement. But Mr. Haynes has spent his life in contact with the chemical industry and with the chief figures who have flitted across, or still occupy, the American stage. A history of

any era is interesting and important if authentic, and it can be taken that this history, documented so efficiently, with so many references to statistics and ascertainable facts, is to be relied upon to give a true picture of events. Volume 4, subtitled "The Merger Era", is concerned with the period 1922–29, Part 1, in fact, being called "The Booming Twenties" when it could be said "Booming automobile, motion pictures, and radio industries create new chemical demands". "The Return to Normalcy", as Haynes calls it, followed on the First World War and witnessed the beginning of the "Boom"; "the reckless orgy of spending" ended it with the "resounding crash of 1929".

The value of the volume depends not so much on the philosophic comments of the author as on the development it details of the growth of new industries, the extravagant development of old industries and of the 'monopoly' which by arrangements and contracts between companies, not only in the New World but also in the Old, sought to restrain the outside from getting into the inside. Haynes describes this tendency in four chapters of general comment, "The Return to Normalcy", "The State of Trade", "American Chemical Mergers" and "Foreign Cartels and Trusts". These chapters form an interesting commentary on the period and lead up to the author's survey of chemical industry in the United States as evidenced by inorganic chemicals, organic chemicals, medicinal and other fine chemicals, and lastly a group which he calls "The Consuming Industries"—fertilizers, pest-control chemicals, plastics and resins, oils and pigments, rayon and other textiles, petroleum and tetraethyl lead—and the final two chapters, "Chemicals in Industry" and "Broadening Chemical Boundaries". So much for the scope of the volume.

It makes fascinating reading for anyone concerned with the various industries treated, but naturally is not generally for the personal bookcase. It is, in fact, a book of reference and a mine of information. The appendixes, too, are full of information, occupying some 120 pages and varying from tariff rates to personal letters to the author, and from lists of witnesses at trials to uniform sales contracts. Neither must the photographs of some scores of American industrial celebrities be overlooked.

The book is printed well up to the high standard of its well-known publishers.

ELECTRON AND NUCLEAR PHYSICS

Electron and Nuclear Physics

By Prof. J. Barton Hoag. Third edition, revised by Prof. S. A. Korff. Pp. xi+522. (New York: D. Van Nostrand Co., Inc.; London: Macmillan and Co., Ltd., 1948.) 27*s.* 6*d.*

THE 1938 edition of Hoag's "Electron and Nuclear Physics" must be well known to all university teachers of physics, and the new revised edition by Prof. S. A. Korff, an authority on electron and nuclear counters, will, doubtless, be very welcome and valuable. The method of presentation, the arrangement, and to a large extent the content also, of the 1938 edition have been retained. The opportunity has been taken to revise the tables of data in conformity with more recent observations, to make minor revisions and additions to the text, particularly in the nuclear physics section, and to add to or extend the experiments which, it will be remembered, are an important feature of each chapter. Nevertheless, the reader will be somewhat disappointed (particularly so after reading the preface to the new edition, where the impression is given that considerable changes have been made) that so little new material, concerning work done in recent years, appears in the new edition.

Honours students of physics should find the book most useful, as it provides, in a condensed yet clearly expressed form, a survey of the many aspects of electron and nuclear physics, as well as helpful hints regarding the laboratory techniques involved. Detailed information must be sought for elsewhere, in more advanced and specialized treatises. The forty-odd experiments of which details are given and which are suggested as student exercises require apparatus which, even in these days, is probably not available except in those university laboratories engaged on nuclear research. The experiments, however, are well chosen, and much benefit can be derived by reading through the descriptions of them even if the student cannot perform them himself. Together with the set of numerical problems that are provided at the end of the book, the student should find excellent basic information in addition to much that will stimulate him to think for himself.

The book is well produced. Some of the line diagrams have been redrawn for greater clarity; but there are still several which could be improved in this way.

Some confusion may arise from the 1938 edition preface, which is reprinted in the new edition, being called "Preface to first edition". The book is divided into three sections: electron physics, nuclear physics, and laboratory techniques. "Electron Physics" was first published in 1929; "Electron and Nuclear Physics" (the three sections) was published in 1938 (for review, see *Nature*, **143**, 1,048; 1939) and was referred to at the time as the second edition. The fly-leaf of the present volume confirms this arrangement.

S. WEINTROUB

PHOTOGRAPHY IN FORENSIC SCIENCE

Photography in Crime Detection

By J. A. Radley. Pp. 186+72 plates. (London: Chapman and Hall, Ltd., 1948.) 21*s.* net.

THE preface states that this book is addressed both to the practising police photographer and to the interested layman. For this diverse public Mr. Radley has covered the subject with exemplary completeness. His approach is realistic and practical. In twelve chapters he deals successively with the routine uses of 'straight' photography in police work, and with the uses in the laboratory of photomicrography, the methods of document examination and photography by infra-red, ultra-violet and X-rays. He has some interesting ideas of his own about applications as yet untried. He has also assembled a large and representative collection of illustrations, knowing well, no doubt, that it is largely by these that such a book is judged; and they are convincing witnesses.

They are almost all excellent and are well chosen for their purposes.

Nevertheless the book is not as good as it might have been. Its defects are, in the main, attributable to two causes. The first springs from the attempt to satisfy both the technical and the non-technical reader. There are several passages of fundamental explanatory matter which should be unnecessary to any competent photographer, but which are so condensed that they are likely to be unintelligible or misleading to the uninformed general reader. The second cause is, or appears to be, careless or hurried writing and compilation. Technical terms which should, by the book's own criteria, be defined are introduced without explanation (for example, Beer's Law). Material culled from other writers is incorporated without sufficient digestion. Messrs. Kodak are not the only manufacturers of photographic material, as many passages suggest. Examples of this non-fatal but irritating carelessness could be amplified and multiplied if space permitted.

Two other general criticisms may also be offered. Many of the explanatory passages which have been criticized above occur quite arbitrarily: clarity would have been gained, space more economically used, and much repetition avoided, if all of this general technical matter had been gathered together in one section or in an appendix. Also, Mr. Radley, as part-author of the standard book on fluorescence analysis, is rather carried away by his own enthusiasm; the proportion of space allotted to ultra-violet photography over-emphasizes its importance to the forensic scientist.

There are a few mistakes and misprints which should be corrected. The curious sentence beginning on p. 29, line 14, makes sense only if "car park" is read for the first "car". One step has been omitted from the description of "contrast-boosting" by copying (p. 71). In certain references to *Nature* appearing on pp. 77–78, the name of Superintendent Cherrill should be coupled with that of H. D. Murray and not with that of G. A. Jones. "Sodium nitrate" (p. 106) should be "sodium nitrite". "Gnome" appears for "grime"(?) on p. 123. The two captions to Fig. 95 have been transposed.

Many of these criticisms are, however, criticisms of detail. This is, after all, the first book on the subject to appear in Britain, and it offers the information which its readers will want, even if sometimes less lucidly expressed than might be desired. The format is pleasing, the paper good, the printing clear and agreeable, and the half-tone reproduction excellent.

H. J. Walls

GRASSLAND FARMING AND FOOD IN BRITAIN

Ley Farming

By Sir R. George Stapledon and Dr. William Davies. Revised edition. Pp. xv+182. (London: Faber and Faber, Ltd., 1948.) 12*s.* 6*d.* net.

In a time of widening suspicion that a progressive dislocation exists between the demand for and the supply of food, very serious consideration is merited by any strong claim, informed by wide experience, that a proved method exists by which the productivity of soil can be greatly increased. "Ley Farming", published in the Penguin Series early in the Second World War, and now produced in a permanent form with the few slight revisions suggested by war-time experience, makes this claim.

The authors are concerned with our permanent grasslands, and their aim is to make into a standard practice in England and Wales the system of ley farming which is already standard practice in large areas of Scotland. They establish that millions of acres of our soil under permanent grass are being largely wasted: by far the greater area of pasture-land is of the third and fourth grade, run-down, weedy and of poor nutritive composition. This fact, seen as "a standing reproach to our methods of farming", may be illustrated quantitatively: 72 lb. of meat per acre per year is about the average yield of our permanent pasture, whereas indifferent pastures, brought into a ley-farming system, have given yields of well over 200 lb., equal to the yields of the best fatting pastures. The results of a recent study (Davies, W., and Williams, T. E., *J. Roy. Agric. Soc. Eng.*, 109, 148; 1948) suggest that the output of four-fifths of our permanent grasslands might be increased by well over 50 per cent on their substitution by well-farmed leys. As regards milk, a properly managed series of leys gives green food of high nutritive value for longer grazing seasons.

The extension of ley farming requires that permanent grassland should be ploughed up and reseeded —either immediately or after one or several arable crops, depending on soil and climate—with an appropriate productive grassland seed mixture, forming the ley. This, after a longer (4–15 years) or shorter (1–3 years) period, determined by soil and climate, during which the soil fertility is greatly increased, is ploughed and placed under arable crops until reseeded with the ley mixture as the start of another cycle. Every ploughable field comes for its turn in arable and its turn under ley grass, and consequently derives benefit from the residues left by the grazing animal and from the rotting-down of the clover-impregnated sod. The authors estimate that well over half of the 15,800,000 acres scheduled as permanent grassland in England and Wales in 1930 was from every point of view fit and proper to be brought into a ley-farming system, and they present in this book a detailed description of the whole proved and flexible technique of the system and of the change-over which, both on the farm and the national scale, would be gradual; the area of permanent grass could be reduced to about 5,000,000 acres by 1955. Our comparatively small area of worn-out arable land also would benefit from incorporation in a ley system.

The authors stress that the change-over is not to be regarded as merely an emergency measure but ought to be carried out because it ensures a much more productive use of land, and also a flexible use, for when the demand is for arable crops the period of ley can be reduced to a minimum. The suggestion, however, that about half of our 590,000 acres of parkland ought to be ley-farmed may perhaps justly be thought to reflect an over-anxiety to exploit to their limit, and all the time, such resources as we have. The fact that in 1946—when the war-time activity of ploughing-up had lost its impetus—the ratio of the area under ley to that under permanent grass was in England and Wales about 1 : 3 and in Scotland 5 : 4, suggests that before we start to move the plough around parks there is very great scope for many years for its increasing use elsewhere.

W. D. Brind

IVAN PETROVICH PAVLOV (1849–1936)

By Prof. B. P. BABKIN
McGill University, Montreal

ONE hundred years ago on September 14 (according to the Julian calendar; September 27, modern reckoning) Ivan Petrovich Pavlov was born, the son of a priest of one of the humble parishes in a provincial town of Ryazan in Russia. His high-school training was received in an ecclesiastical seminary in Ryazan. He graduated afterwards from the Natural Science Faculty of the University of St. Petersburg, and in 1879 obtained his M.D. degree from the Medico-Chirurgical Academy in that city. During 1879–90 he was director of research in the laboratory of the famous clinician S. P. Botkin; in 1885–86 he studied under Carl Ludwig in Leipzig and R. Heidenhain in Breslau; he was appointed in 1890 professor of pharmacology and in 1895 professor of physiology in the Military-Medical Academy in St. Petersburg. Almost simultaneously, namely, in 1891, he became director of the Department of Physiology in the Institute of Experimental Medicine, a position which he held until the day of his death. He was a member of many learned societies in Russia and abroad and held honorary degrees from several universities. He was married and had three sons and one daughter. He died in St. Petersburg on February 27, 1936.

This life, so simple externally, was extremely rich and varied in a spiritual sense. Pavlov was a pathfinder, who always looked for unexplored fields. With a genius for experimentation, a systematic and searching mind, and an uncompromising devotion to science and a firm belief in it, he became one of the most renowned physiologists of his time.

Roughly, the physiological work of Pavlov may be divided into three periods. The following fields were investigated by him: (1) circulation; (2) functions of the alimentary canal; (3) central nervous system.

All the work of Pavlov was permeated by the idea of 'nervism', as he called it, which postulated that most of the bodily functions are regulated by the nervous system. He certainly did not deny the humoral or hormonal transmission of impulses, especially when the functions of the endocrine glands became better known. But his chief interest always was the organism as a whole, and the interrelation of the organs, and its reaction to the outside world through the nervous system.

Work on Circulation. The principal work of Pavlov in this field was on the innervation of the heart. Simultaneously and independently of W. H. Gaskell, Pavlov discovered in 1882–83 the augmentor effect of the sympathetic nerve stimulation on the heart. According to him, the heart of a warm-blooded animal is supplied by two pairs of nerves. They derive from the sympathetic and the vagus nerves respectively: 'rhythmic' nerves (accelerator and inhibitor) and 'dynamic' nerves (augmentor and 'abator' nerves).

Modern physiology prefers to speak about rhythmic and dynamic *influence* of the nerves on the heart and does not ascribe these effects to four kinds of special nerve fibres. However, the fundamental fact of the dynamic function of the sympathetic nerve discovered by Pavlov remains unshaken.

In 1885, with one of his co-workers, Pavlov worked out a method of isolation of the heart in the dog *in situ*. This method was improved and modified much later by E. H. Starling and is known under the name of the "heart–lung preparation".

Gastro-intestinal Tract. During fifteen years, from the end of the 'eighties of the last century to the beginning of the present, Pavlov studied almost exclusively the physiology of the digestive glands, and to a much lesser degree the motility of the alimentary canal. This work was epoch-making. The results Pavlov presented in the form of a book of lectures in Russian (in 1897) under the title "The Work of the Digestive Glands", which was translated into German (1898), French (1901) and English (two editions, 1902 and 1910). Without exaggeration, the facts discovered by Pavlov, and his ideas, became the foundation of modern gastro-enterology, theoretical and clinical. Everything was new here: a new and unprecedented development of physiological surgery; new and brilliant experimental methods; the discovery of an extraordinarily large number of facts concerning the innervation of different glands, the enzymatic composition of the secretions, the interrelation between the different parts of the alimentary canal, and so on. For the first time, an exact picture was given of the work of the alimentary canal, based on experimental material.

The theoretical foundation on which this magnificent structure was built was: (1) the specific excitability of the gastro-intestinal tract; and (2) the exclusively nervous control of the activity of the digestive glands. The theory of the specific excitability of the mucose of the alimentary canal, first formulated vaguely by N. Blondlot (1843) and fully developed by Pavlov, replaced the crude idea of general excitability, and is retained in somewhat modified form by modern physiology and gastro-enterology. Pavlov's theory of the exclusively nervous control of the functions of the alimentary canal had to be modified after the discovery of pancreatic secretin by W. M. Bayliss and E. H. Starling in 1902.

Pavlov's achievements in the physiology of the gastro-intestinal tract were crowned in 1904 with the award of the Nobel Prize. He was the first physiologist who received this great honour.

Conditioned Reflexes. The last thirty-five years of his life Pavlov devoted to the study of the functions of the cerebral cortex, or, as he called it, more correctly, "higher nervous activity". He attached a far greater importance to this than to his previous work.

Pavlov was led to the studies of the functions of the central nervous system by observation of 'psychic' salivary and gastric secretion which he had the opportunity to see so often. The questions which he asked himself were: (1) Is the cerebral cortex subjected to the same law of reflex action as the rest of the nervous system, notwithstanding its supposed relation to the conscious processes in the animal? and (2) Can the 'psychic' reaction be investigated by purely physiological methods?

Pavlov answered both questions positively. He discriminated between the *unconditioned*, innate

reflexes, regulated by the lower parts of the central nervous system, and *conditioned*, acquired reflexes, for the formation of which the presence of the cerebral cortex is of paramount importance. Through the combination of any indifferent stimulus and an unconditioned reflex, a corresponding conditioned reflex is formed. Pavlov certainly did not look on such a highly organised animal as the dog, for example, as a reflex machine; but he was firmly convinced that a conditioned reflex forms the basis of any 'psychic' reaction of the animal. Looking on his study of conditioned reflexes as strictly physiological, he excluded from it any considerations of the psychic states of his experimental animals. However, he spoke repeatedly about the time, far away as it may be, when the coalescence of physiology and psychology will become possible.

The experimental material collected by Pavlov and his co-workers is enormous[1]. Thousands of experiments proved that a conditioned reflex is indeed a reflex, and established multiple rules for its behaviour. Moreover, with the help of conditioned reflexes, such pathological phenomena as neuroses were produced in dogs, and the mechanism of their origin was disclosed. Thus, for the first time in the history of physiology, its methods were applied to the study of the functions of the cerebral cortex, intimately related to the psychic states of an animal, and the activity of the cortex was discussed from a physiological point of view. Pavlov's elaborated theory of conditioned reflexes was purely provisional, and so considered by himself. Its formulation was necessitated by the quickly accumulating facts which had to be brought into relationship.

Although Pavlov had predecessors—the outstanding Russian physiologist, I. M. Sechenov, and the famous English neurologist, J. Hughlings Jackson—they only prepared the way for Pavlov's daring attempt to study the functions of the *whole* central nervous system from a physiological point of view[2].

Contrary to the swift universal recognition of Pavlov's work in the field of gastro-enterology, the idea of the conditioned reflexes did not find full approval. It was looked on with greater favour by psychologists, especially the representatives of the objective psychology in the United States, than by physiologists and neurologists. Of course, Pavlov's facts could not be disputed, and the criticism was directed towards the theoretical part of his teaching.

It would not be a mistake to say that the conception of conditioned reflexes was much in advance of its time and was not quite understood by many. But the day will come when the achievements of Pavlov in neurology, normal and pathological, will be fully recognized and appreciated.

If we look in retrospect on what Pavlov achieved during the span of one human life, we may say without reservation that this remarkable man did the life-work of two great men. His name would never be forgotten if he had left us only the legacy of his gastro-enterological work. But he added to this another achievement more imposing than the first, that of the physiology of the "higher nervous activity".

[1] Only a part of Pavlov's work is available to English-speaking readers. It is contained in his "Conditioned Reflexes" (Oxford University Press, 1927); "Lectures on Conditioned Reflexes" (International Publishers, New York, 1928) and "Conditioned Reflexes and Psychiatry" (International Publishers, New York, 1941).

[2] See Babkin, B. P., "Origin of the Theory of Conditioned Reflexes", *Arch. Neurol. and Psychiat.*, **60**, 520 (1948). A full discussion of Pavlov's scientific achievements will be found in my "Pavlov: a Biography" (University of Chicago Press, in the press).

THE IONOSPHERE AND THE PROPAGATION OF RADIO WAVES

DURING July 14–16 the Physical Society held its summer meeting at the Cavendish Laboratory, Cambridge, on the subject of "The Ionosphere and the Propagation of Radio Waves". The purpose of the conference was to survey research work in progress and particularly to relate the knowledge acquired by the academic workers to that obtained by the practical users. There were five sessions devoted to different aspects of the subject.

The first session dealt with the regular behaviour of long and very-long waves returned from the ionosphere. Mr. R. N. Bracewell and Mr. J. A. Ratcliffe outlined some of the results obtained by the Cavendish Laboratory Radio Group since 1935 on frequencies of 16–127 kc./s. One point of major interest concerns the amplitude of the downcoming wave on a summer day. Near vertical incidence the amplitude is quite large on 16 kc./s. (reflexion coefficient is 0·15), but is unmeasurable on 30 kc./s., and it remains unmeasurable as the frequency is increased up to about 2 Mc./s. The low-frequency limit of the range of small amplitudes appears to change with season, time of day, and obliquity of the reflexion, and it appears probable that there is a fundamental change in the mechanism of reflexion at this frequency. Experiments with waves of frequency 16 kc./s. have indicated a change in the conditions of propagation as the obliquity of reflexion is increased through an angle of incidence of about 70°; for more oblique incidence the reflexion coefficient is greater and the polarization is different. An account was given of the diurnal variation of the amplitude, and the change of reflexion height, of waves of frequency 16 kc./s. and 100 kc./s. incident nearly vertically, and it was emphasized that on 100 kc./s. there is an asymmetry in the curve showing the diurnal change of height, which might be explained if it is assumed that the region responsible for reflecting these frequencies is separated into more than one layer.

Mr. K. W. Tremellen discussed operational results obtained by the Marconi Co. on very long waves in the 1920's. He emphasized that many of the recent experimental results apply only to propagation over short distances, up to about 500 km., and that the older operational experience leads us to expect radical changes at greater distances. In particular, operational experience indicates that on 16 kc./s. propagational phenomena depend markedly on geographical direction. Mr. W. T. Sanderson described observations made during the operation of the Decca Radio Navigational System, working on frequencies near 100 kc./s. From the 'phase' errors obtained at different distances, it is possible to deduce that the reflexion coefficient is greater for distances greater than about 250 km. The overall errors of the system, including their dependence on atmospheric noise, are approximately proportional to the secant of the zenith angle of the sun. Mr. Caradoc Williams described experiments made at the Royal Aircraft Establishment on the navigational systems known as Decca, P.O.P.I. and Consol, all working on frequencies near 100 kc./s. He deduced that the error of the system increases with the length of the base line. A measurement of the daytime interference pattern formed between the ground wave and the

downcoming wave on 100 kc./s., at distances near 550 km., showed an effective height of reflexion of about 68 km. and a reflexion coefficient of 0·03–0·06. It appears that on 100 kc./s., as on 16 kc./s., the reflexion coefficient increases as the obliquity of reflexion increases.

In the discussion resulting from these papers, Dr. F. W. Chapman and Mr. E. T. Pierce quoted evidence derived from an examination of the wave-forms of distant atmospherics, which can be considered to be radio impulses of long wave-length. It was suggested that sometimes the results can be explained if the polarity of the field is assumed to be reversed at reflexion at the ground and the ionosphere, and also that on some occasions the more oblique reflexions from atmospherics appear to come from a region at a height of about 40 km.

The second session was devoted to the regular behaviour of medium and short waves. Part of this session dealt with the forecasting of oblique-incidence transmission conditions, and it was pointed out that this resolves itself into two separate problems: the first is that of deducing oblique propagation conditions when conditions are known at vertical incidence; and the second is that of forecasting the vertical-incidence conditions expected at some future time. Dr. W. J. G. Beynon showed how oblique-incidence transmission conditions can be deduced from a knowledge of conditions at vertical incidence, and explained that the deduction of maximum usable frequencies gives good agreement with experiment, but the deduction of absorption at oblique incidence is less satisfactory. Mr. A. F. Wilkins described how the forecasting of transmission conditions at oblique incidence, involving both the forecasting of vertical-incidence conditions and the deduction from this of oblique-incidence propagation, has been tested against the observed reception of signals from America, and he pointed out that it is not possible to forecast within narrow limits. Mr. K. R. Eldredge read a paper by J. A. Pierce of the Cruft Laboratory, United States, which described observations made on pulses of frequency 16 Mc./s. propagated over distances of 6,000 km. and 1,300 km. The results had been analysed in terms of multiple-hop and Peddersen rays, and it was shown how to select a frequency which would give only one pulse at the receiver, and would therefore allow the maximum rate of signalling without ionospheric distortion.

Mr. B. Stjernberg (Chalmers Laboratory, University of Gothenburg) and Lieut.-Colonel A. B. Whatman showed P'–f records taken in high latitudes. Mr. Stjernberg's records were presented in the form of a film showing the ionospheric behaviour over two days speeded up 480 times. The records shown merited the description given by Mr. K. W. Tremellen, who called them 'the ionospheric chamber of horrors'. In the discussion which followed this session it was emphasized that it is important to determine whether the unusual echoes observed in polar regions come from directly overhead.

The third session, dealing with the irregular behaviour associated with solar events, was opened by Mr. W. R. Piggott, who concerned himself mainly with the nature of ionospheric storms, which he divided into the quasi-auroral and the regular type. He traced the way in which both types of storm develop with time, and the way this development differs at different latitudes. M. R. Rivault then read a paper by Dr. R. Bureau of the Laboratoire National de Radioélectricité on the subject of the anomalous increases of atmospherics which are recorded on very-long wave-lengths at times of sudden ionospheric disturbance. The more important properties of these anomalies have been described previously, but in this paper attention was directed to the anomalies among the anomalies: sometimes a very long wave enhancement of signal may be associated with an increase of amplitude on short waves instead of the decrease normal during a sudden disturbance. Dr. K. Weekes outlined the observations being made in Cambridge on the phase changes suffered by the downcoming wave on frequencies of 2,400, 113, 70, 40 and 16 kc./s. during sudden ionosphere disturbances. He also discussed the changes of amplitude involved, and in the discussion Mr. J. W. Findlay pointed out that, if the effects observed on 2,400 kc./s. are due to the sudden production of a Chapman region, then it must be formed with its maximum at a level where the collisional frequency is 2×10^8 sec.$^{-1}$.

In the fourth session, concerned with the formation of ionized layers, Dr. K. Weekes directed attention to some of the doubtful assumptions which are often made in theoretical work on the subject. He pointed out that experiments do not indicate that the effective recombination coefficient is independent of pressure, nor do they suggest that region E is very similar to a 'Chapman' layer, since its P–f curve often shows a series of subsidiary penetration frequencies. Even the 'law' $f_c^4 \propto \cos\chi$, which relates the critical frequency f_c to the zenith angle χ of the sun, is not at all accurate; the results are different in different parts of the world, and depend upon whether the variation of χ is taken through the day or through the season.

Mr. D. R. Bates followed with a review of the present ideas on the origin of the regions. New calculations of the continuous absorption coefficient of atomic oxygen indicate a lower value than previously and give the layer maximum between regions E and F_1. Owing to the marked change in recombination coefficient with height, it is unnecessary to postulate a separate ionizing agency for regions F_1 and F_2. There is good evidence, from the intensity of the twilight flash of N_2^+ bands, that ionization of molecular nitrogen plays no appreciable part in the origin of the ionosphere, so that region E may be assumed to be due to ionization of molecular oxygen either by quantum energies of about 12·5 eV. or by high-energy quanta ($\sim$ 200 eV.).

Mr. Bates estimated the ionization-rate at D-region levels due to various processes which have been suggested and showed that atomic sodium and metastable atomic oxygen are very unlikely origins, but that nitric oxide, if present in concentration 10^{-4}, may provide sufficient ionization.

In the last session, opened by Mr. J. W. Findlay, stress was laid on the fact that on many occasions the ionospheric regions seem to be irregular in the horizontal direction, so that reflexion from them is not like reflexion from a plane mirror. Experiments made in Cambridge were described, as a result of which estimates have been made of the amount of the horizontal irregularity, and of the turbulent and steady motions of the ionosphere. Winds have been observed at heights near 100 km., and there is some sign of a seasonal variation of direction. In the discussion it was mentioned that winds had also been observed, by other radio methods, in region F. The effect of irregularities on the direction of arrival of high-frequency waves was discussed by Mr. W.

Ross, who stressed the importance of the larger scale 'ripples' which appear to occur, especially on region *F*. Mr. G. Millington discussed the question of 'long-distance scattered' signals, and whether they were produced by the irregularities in region *E* or on the ground. M. R. Rivault gave examples of some diffuse and scattered echoes observed near the critical penetration frequency for region *F*, and it was again questioned whether these echoes were incident vertically or obliquely.

Finally, Dr. A. C. B. Lovell summarized the effects which would be expected to be produced by the 450 kgm. of meteoric material which burn up each day in the atmosphere near the level of region *E*. Although there is a relation between the number of meteors and the presence of sporadic *E*, he gave reasons for supposing that meteors cannot be assumed to be responsible for all sporadic *E*.

J. A. RATCLIFFE

PHYSIOLOGICAL AND PSYCHOLOGICAL EFFECTS OF HIGH TEMPERATURE AND HUMIDITY IN MINING AND METALLURGICAL WORKS

AT the Fourth Empire Congress on Mining and Metallurgy, a discussion on "The Physiological and Psychological Effects of High Temperature and Humidity on Workers in the Mining and Metallurgical Industries" was held at Oxford on July 14. In the opening paper, by Sir David Brunt, the factors which determine the thermal equilibrium of the human body were enumerated and discussed briefly. These factors are:

(*a*) The rate at which heat is generated in the body, this rate depending on the rate at which work is being done.

(*b*) The dry- and wet-bulb temperatures of the air.

(*c*) The temperatures of radiating surfaces, such as walls and roofs, in the immediate environment.

(*d*) The rate of movement of the air.

Attention was directed to the fact that whenever work is done there is a rise of body temperature. This should be borne in mind in the interpretation of observations of working conditions. A moderate rise of body temperature is not harmful. Both these points were later emphasized by Dr. A. Caplan.

The ability to sweat is the body's chief protection against a continuous rise of body temperature; but the losses of water and of salt in the sweat must be replaced if health and efficiency are to be maintained.

It was shown that when the skin is completely wetted with sweat, the rate of loss of heat from the body is determined largely by the wet-bulb temperature of the air, the dry-bulb temperature having no direct effect, except in so far as it may control the temperature of the radiating surfaces. In these conditions the rate of loss of heat by convection and evaporation from the nude skin is proportional to $\sqrt{v}(I_s - I_w)$, where v is the rate of air movement, and I_s and I_w represent the total heat content of saturated air at the temperature of the skin and at the temperature of the wet bulb respectively. From the above considerations it is possible to represent the conditions of heat balance in the *nude* body by a tractable equation; from this equation the limiting conditions in which the body temperature can be guarded against continuous increase can be deduced for any given rate of work and of air movement. These limiting conditions are the heat-stroke limits for a nude man. A diagram was shown giving these limiting conditions for a range of rates of work and of air movement.

While an increase of ventilation from a few feet per minute up to 200 feet per minute produces a very marked rise in the limiting temperatures, further increase of ventilation is followed by relatively slight rise, and it may be concluded that in hot, humid mines an improvement in working conditions is to be looked for by the drying and cooling of the air, rather than by an increase of ventilation.

From the diagram referred to above it was inferred that air with a wet-bulb temperature of 83° F. represents a limit beyond which a continuous shift would be impossible without a rise of body temperature. The same limit was laid down by Dr. Caplan on the basis of his experience in the Kolar Gold Field.

Dr. A. Caplan, in a paper on the effects of high environmental temperatures on underground workers on the Kolar Gold Field, emphasized the complexity of the heat-regulating mechanisms of the human body. He stressed the rise in body temperature which always accompanies work, stating that a rise above 102° F. is a sign of heat intolerance, indicating a need for artificial acclimatization. In 80 per cent of cases of heat collapse, an individual predisposing factor, such as unacclimatization, loss of acclimatization or disturbances of health, contributed to the collapse. The first sign of impending heat collapse is a fall of blood pressure, reducing the blood supply to brain, heart, muscles and skin, and resulting in fatigue, giddiness, headache and nausea.

In his discussion of water metabolism, Dr. Caplan pointed out that there is an increasing diminution of the total body fluids as the shift progresses, aggravated by the fact that in hot environments blood is diverted from the alimentary tract to the skin and muscles, so that the absorption of fluids is diminished, and may be entirely absent. No serious danger arises unless reserve tissue fluids are low, as would happen after vomiting or diarrhœa.

Dr. Caplan discussed briefly some important psychological factors. He pointed out that the strain on the whole organism produced by hard work in hot atmospheres leads to mental fatigue, which makes the worker apathetic and neglectful, reducing his working efficiency and making him prone to accidents. The workman becomes resentful and dissatisfied, and is easy prey for the agitator; labour unrest and all its implications will follow.

On the basis of his experience on the Kolar Gold Field, Dr. Caplan gave a wet-bulb temperature of 83° F. or lower as prescribing favourable conditions for comfortable and unimpaired output, and 90° F. as the crucial wet-bulb temperature above which conditions are dangerous to health.

The need for acclimatization of native workers in hot and humid mines was discussed in two of the papers presented at this session. Dr. J. S. Weiner, of the Medical Research Council Climatic and Working Efficiency Unit, discussed the effects of acclimatization on the working efficiency of Bantu workers, as observed in the City Deep Mine, Johannesburg. Tests were made on a group of eight unacclimatized Bantu, and on another group of eight acclimatized Bantu, doing a standardized task in hot humid

conditions, the test being identical with that used in many laboratory tests on Europeans in varying states of acclimatization. It was found that even the experienced Bantu never quite reach the same state of acclimatization as the European, a result which appears to indicate that the Bantu has no high degree of 'natural' heat tolerance. A serious obstacle to the comparison of Bantu and European workers is the absence of reliable measures of the physical effort made by native workers in hot mines.

A paper by Dr. A. O. Dreosti described investigations carried out at the Central Native Mine Hospital, City Deep, Johannesburg, to determine the reaction of native mine labourers to hard muscular work in hot and humid environments. The tests, consisting of shovelling rock, lasted one hour, and mouth temperature was observed at the beginning, after half an hour, and at the end of the test. The results may be tabulated as shown below.

Mouth temp. after test	Classification	Frequency	Acclimatization recommended
100·8° F.	Heat tolerant	25 per cent	4 days
100·8–102° F.	Normal	60 ,,	7 ,,
102° F.	Heat intolerant	15 ,,	14 ,,

Rise of mouth temperature was assumed to be the best measure of acclimatization. Of the natives subjected to tests for seven days, the majority showed a diminution of rise of mouth temperature after five days. Those who showed no diminution were those whose temperature rose above 102° F. on the first day. These men took longer than the others to acclimatize, and were given fourteen days acclimatization. The degree of acclimatization gained by the men tested by Dr. Dreosti appeared to be lost in a very short period of absence from the mine.

In the seven years 1932–39, there was no single case of heat-stroke among the heat-tolerant group, and Dr. Dreosti suggests that a rather simple test such as he describes will ensure that heat-intolerant men are protected from the danger of being too rapidly promoted to work in hot stopes. The tests were used at the City Deep over a period of years, but were later abandoned as unnecessary, conditions in the mine having been so improved as to remove serious risk of heat-stroke.

A review of the conditions in British mines, by A. E. Crook, F. Edmond, J. Ivon Graham and B. R. Lawton, gave a brief summary of the factors controlling the temperature conditions in underground workings. It was stated that the flow of heat from strata, the oxidation of coal dust, radiation from walls and roofs, and the heat given off by machines, are relatively unimportant in well-ventilated mines. The use of wet-cutting methods to obviate dust leads to considerable evaporation and humidifying of the atmosphere, both at the coal face and during the transit of wet coal to the mine shaft. In a series of appendixes are given extensive series of actual observations in various collieries of temperatures of dry- and wet-bulb thermometers, of air speed and effective temperatures, as well as of readings of dry and wet katathermometers.

Messrs. W. A. Attwood and W. B. Lawrie presented a paper on working conditions during certain melting and smelting processes, and demonstrated very clearly that work in the metallurgical industry can be as severe as in deep mines. In many industrial concerns the work is carried out in very hot buildings with congested plant, while men at times work to the limit of endurance. Improvement is to be looked for in some cases by rebuilding, in others by improvement of natural ventilation or by the installation of forced ventilation.

In the subsequent general discussion, Dr. J. K. Lindsay pointed out that during work in very difficult conditions, the brain is the first organ to suffer, the onset of mental fatigue preceding the onset of physical fatigue, and lasting long after the shift in the mine is ended. The desire to get to a cooler place leads to slipshod work.

Mr. D. G. Malherbe, chief inspector of mines, Union of South Africa, pointed out that the silicosis danger demands wet mining, which leads to rise of wet-bulb temperature at the working stopes. It is difficult to economize wisely in the use of water, since some miners when asked to economize use no water. Mr. Malherbe referred to the possibility of the extension of gold mining to a depth of 10,000 ft. This would best be done by gradually deepening existing mines to 10,000 ft., so as to learn the problems by experience.

Prof. F. B. Hinsley stressed the value of high speed of ventilation, in that the air is thus got into the mine quickly, without being warmed by its environment. He pointed out that in modern mines in Great Britain there is a great increase in the amount of dust, and if this is suppressed by the use of water the wet-bulb temperature is raised. Dr. K. J. Irvine also stressed the importance of high rate of ventilation, and of good food and good personal relations for the worker.

J. D. Farmer, an expert in air conditioning, directed attention to the fact that the mine cooling-plants on the Rand, in the Kolar Gold Field and elsewhere, are all surface plants. We are faced with the prospect of having to deal in British mines with wet-bulb temperatures up to 80–85° F. If this is to be met by the installation of cooling-plant, a decision is required as to whether the plant is to be on the surface or below, and since it will require some years to design a suitable plant, it will be advisable to put the problem to the refrigerating engineer soon.

D. B.

NEW MATERIALS AND THEIR ENGINEERING SIGNIFICANCE

THREE papers read at a meeting on September 1 before Section G (Engineering) of the British Association brought together some interesting information and suggested interesting possibilities in the application of new engineering materials.

The first paper, "New Dielectric and Semi-Conducting Materials", by Dr. R. W. Sillars, began with a discussion of the behaviour of the sulphides and oxides of various elements, and mixtures of these, when carrying an electric current at varying temperature. It is found that oxides and sulphides, such as those of copper, lead, nickel and titanium, have a resistance which is profoundly affected by small changes of composition or of impurity content, and that they all possess a large negative temperature coefficient. Moreover, when they are brought into electrical contact with another material or another piece of the same material, a voltage appears across the contact which is not proportional to the current flowing and may depend upon its direction.

These semi-conductors differ from metallic conductors in that the electrons which carry the current

are the few which have escaped from a weak attachment to fixed ions, to which they would have been held if the temperature had been very low. A semi-conductor may, therefore, be regarded as an insulator which is too hot to insulate even at room temperature. The fixed ions from which these conductivity electrons are released do not belong to the lattice structure and are referred to as impurities. Temperature coefficients of −3 per cent to −5 per cent per degree centigrade are obtainable with resistivities varying from hundreds, to hundreds of thousands of ohm/cm., the higher resistance coefficients being generally associated with the materials of higher resistivity, while in a given material the temperature coefficient varies inversely as the square of the absolute temperature. The materials used commercially are nickel, cobalt and manganese oxides and mixtures of these fused or sintered into small beads and provided with two fine platinum wire electrodes, or manganese oxides sintered into disks, rods or thin flakes, and provided with deposited metal film electrodes. It is possible to give these semi-conductors rectifying qualities under suitable conditions by bringing them into contact with a dissimilar conductor; if the surfaces of two pieces of similar semi-conductor are placed in contact, a fault-current curve of a similar type of more or less symmetrical shape may be obtained. Both silicon and germanium have good rectifying properties and may be used with advantage in radio work, as the capacity across the rectifier barrier layer is very small. Rectification is, indeed, found to be effective only when contact is made over a very small area, of the order of 0·0005 cm. diameter.

Germanium is also used in the 'Transistor' amplifier which was announced from the Bell Laboratories last year. This consists of two point contacts very close together, on the surface of a piece of germanium, but not necessarily on the same surface, and a large base electrode which corresponds with the cathode of a thermionic valve, except that it is biased positive and not negative with respect to the other output terminal. The input point is biased slightly in the direction of easy conduction, that is, positive. The germanium used is the same as that for high back-voltage rectifiers, that is, with the highest possible resistance. The main features of this rectifier are an input impedance of 100 or 200 ohms, an output impedance of several thousand ohms and a maximum output of a few tens of milliwatts from a pair in push-pull. Operation is satisfactory up to 10 megacycles per second. The noise-level at audio frequencies is, however, high as compared with the thermionic valve.

Dr. Sillars next directed attention to recent progress in the production of insulation, and pointed out that organic substances consisting only of carbon and one other monovalent element have very low dielectric loss, as exemplified in the polymers of styrene and ethylene. The main limitation of polyethylene is, however, its low softening point; in this respect the polymer of tetrafluorethylene, the molecules of which have a mutual attraction so strong that the substance tends to decompose before it has softened and is insoluble in all liquids, offers some possibilities. Its very stability, however, tends to make it intractable in manufacturing processes.

For the insulation of electrical machines, materials are required which will withstand the higher temperatures of operation now employed. Glass fibres in combination with organic varnishes are often used, but the brittleness of the glass may cause trouble. Recently, asbestos paper has become available, and this, impregnated with heat-resisting varnish, has been found useful where ability to withstand high temperature is of greater importance than high breakdown strength. The new fibre made from terephthalic esters, known as 'Terylene', promises to be useful as it will withstand a temperature of 180° C. Among ceramics, the low loss steatites and the oxide – zirconium oxide – titanium dioxide are now in common use; but others may be obtained by sintering together the oxides of barium, strontium and titanium in various proportions, resulting in materials of permittivities up to several thousand. These high-permittivity materials are, however, rather sensitive to temperature changes, and this fact, together with the difficulties of handling very thin ceramic sheets, may prove an obstacle to their general use for large capacitors.

The second paper, "Magnetic Materials for Electrical Power Plants", by Dr. F. Brailsford, began by indicating the magnetic properties important to the designer of electrical machines. A low hysteresis loss is desirable, together with high permeability at flux density of some 15,000 gauss. There followed a general review of the theory of ferromagnetism, and it was shown that theoretical work by Becker, Kirsten and others had demonstrated that low hysteresis loss is to be expected in a material in which there is easy movement of the domain boundaries, and that all sources of internal stress producing lattice distortion should be eliminated. There appears to be little doubt that the chief causes of poor magnetic properties are associated with impurities present in the material, carbon and sulphur being particularly harmful. The work of Honda and Kaya, on large single crystals of iron, and silicon–iron, indicate further that magnetization is more easily accomplished along a cube edge than across a cube diagonal or a face diagonal. In the case of hot-rolled iron, and silicon–iron polycrystalline sheets, there is a more or less random arrangement of the crystals, so that the magnetization curve is a mean of that for all magnetization directions, giving a knee point at 13,500 gauss for a 4 per cent silicon–iron; but the experimental work of Yensen, Cioffi and others has shown that if processes of manufacture are controlled to keep impurities to a minimum and to produce a large grain size, a considerable improvement in magnetic quality is possible. In some of the better grades of hot-rolled material produced in the United States, the carbon is reduced by a decarburizing treatment, and large grain size is obtained by special rolling. This has resulted in the production of American steel of a better magnetic quality than the material of similar composition produced in Great Britain. A further improvement may be obtained by a process of cold rolling, which is now standard practice for certain steels in America. Cold work on the steel tends to orient the cube edges in the direction of rolling, and therefore to give a higher permeability in this direction than a direction across the plate, or a direction normal to its surface, which contain the diagonals of two cube faces. There seems to be a possibility, if rolling methods can be evolved which would orient the cube edges along the direction of rolling and at right angles to it, that a still further increase in permeability could be obtained.

An account was given of the alloys of iron and nickel; but it was pointed out that, in spite of their very low hysteresis loss, the use of these alloys is restricted to instrument and communication work on

account of their high cost and low saturation flux-density. In this class of materials the ferrites were mentioned, certain oxides upon which research work has been in progress in Holland and which show initial permeabilities as high as 4,000 and saturation values of about 5,000 gauss.

The paper concluded with a short account of the work of Martindale and Langford in producing, under laboratory conditions, large crystals of silicon–iron in sheet form.

In his paper on "Metals for High Duty", Dr. R. W. Bailey first gave an account of the improvements which have been achieved in the quality of the carbon steel used for structural parts. Greater strength has been obtained without undue sacrifice of other properties by modification of the normal elements of composition, principally by increasing the manganese and silicon contents beyond their usual amounts. Such steels have found application in structural work such as bridges and high-duty railway rolling stock. A further improvement in the quality of steel by the development of alloy steels began with the addition of nickel, and later the usefulness of chromium was appreciated; this element is extensively used for low-alloy steels of high reliability and moderate cost. High-duty steels for structural purposes should also resist atmospheric corrosion, and the addition of about 0·5 per cent of copper has been found advantageous in this respect. A structural steel made by the United States Steel Co. has used silicon and chromium to raise the yield point and tensile strength, and copper and high phosphorus to improve corrosion resistance, giving a steel of approximately the following percentage composition:

Carbon	0·08	Silicon	0·7
Manganese	0·3	Chromium	1·0
Phosphorus	0·13	Copper	0·4
Sulphur	0·08		

Such a steel has been used extensively in the United States for railway carriages. It has a yield point of 26 tons per square inch, a tensile strength of 34 tons per square inch and an elongation of 25 per cent on 8 inches. A further increase in the yield point and tensile strength is obtained by the addition of nickel up to 0·5 per cent, and plates for structural work having a yield point of 28 tons per square inch and a tensile strength of 40 tons per square inch are obtainable.

For high-duty forgings, nickel–chromium and nickel–chromium–molybdenum steels have been used for some time. In small parts, such as bolts, a tensile strength of 100 tons is attained, and quite large forgings may have a tensile strength of 70 tons per square inch. High duties, however, necessitate a high degree of freedom from defects, and a type of defect which made its appearance in nickel steels and became more apparent in nickel–chromium and nickel–chromium–molybdenum steels was the hair-line crack, upon which a large amount of research work has been carried out. The major factors concerning its cause and prevention have become known, but it still appears sporadically.

The production of steels which would maintain their characteristics at high operating temperatures in steam and chemical plants was helped by the investigations of J. H. S. Dickenson, on the creep testing of alloy steels. The work soon disclosed the limits of usefulness, in steam plant, of carbon steel, and the existing nickel–chromium–molybdenum steels with a low nickel content also left much to be desired. Dr. R. W. Bailey's creep-test data indicated that although this steel offered good resistance at temperatures up to 450° C., it fell off rather rapidly at higher temperatures; the nickel present was suspected as being responsible for this. The results obtained by Promper and Pohl in Germany had indicated the stiffening effect of molybdenum upon carbon steels, and it was thought that advances might be made by reducing, or even eliminating, the nickel and increasing the molybdenum content. These anticipations were realized, and the chromium–molybdenum steels now widely used for bolts working at high temperatures were introduced. A further advantage of eliminating the nickel was a virtual immunity from embrittlement, and a greatly reduced risk of hair cracks, and of cracking during manufacture. Although this steel met the requirements of steam plant; working at high pressures and temperatures, a call for a steel which would withstand more severe conditions was anticipated by experimental work undertaken on a basic 0·5 per cent molybdenum steel, in order to determine the influence of a second added element, and also of tertiary elements. It was concluded from this work that a molybdenum–vanadium steel offered the best possibilities. The turbine cylinder, its bolts and turbine diaphragms, plating, the rotor and steam piping of Battersea Power Station Set 4*a* were ordered in this material in 1937. The developments which have been described were inspired by the need to maintain stress-carrying capacity and permissible deformation at increased operating temperatures. Increasing the temperature reduces the permissible stress for a particular steel until a stress is reached where parts would be too massive, and another steel becomes necessary. As temperatures rise, therefore, the problem of finding a steel to keep the working stress within satisfactory limits is largely a metallurgical one. The question of surface oxidation is bound to arise as temperatures are raised, and these increased temperatures are likely to compel the use of high-alloy or austenitic steels.

The development of gas turbines for aircraft forced the production of new and improved alloys for operating temperatures well above those reached in steam plant; but the desired life of the turbine being only about a three-hundredth of that expected of a normal steam power plant, working stresses could be used which would have been quite inadmissible in the steam set. For this reason and because a degree of cooling could be introduced, it was found possible to use ferritic-steel disks. For blading, however, materials of the highest capacity for duty at elevated temperatures are necessary. Extensive investigation and development work both in Great Britain and in the United States have led to the production of alloys the chemical compositions of which fall conveniently into the groups shown in the accompanying table.

It is of interest to note that the alloys which have the highest performance, namely, those in Groups 3, 4 and 5, are either free, or nearly free of iron.

Alloys which resist deformation at high temperatures require special techniques in manufacture, and processes of precision casting and sintering have been introduced. The factors of cost and availability are both important in the selection of alloys, the first in the industrial possibility of gas turbines and the second in connexion with military and naval requirements. In industrial gas turbines a range of alloys would be used, chosen as those which would meet most economically the conditions occurring at different

Group	Typical Alloy
(1) Chromium - nickel - iron + small additions of molybdenum, tungsten, columbium and titanium.	Firth-Vickers *F.C.B.* (*T*). C, 0·12; Si, 0·6; Mn, 1·6; Ni, 12·5; Cr, 18·0; Cb, 1·45. Firth Vickers H.R. Crown Max. C, 0·25; Si, 1·5; Ni, 12·0; Cr, 24·0; W, 3·0.
(2) Similar to (1) but with nickel exceeding chromium.	S. Fox and Company. Red Fox 33. C, 0·1; Si, 0·8; Ni, 31·0; Cr, 20·0; Ti, 1·0.
(3) Nickel-chromium + small additions of aluminium and titanium.	Mond Nickel Company's Nimonic 80. C, 0·05; Si, 0·70; Mn, 0·4; Fe, 3·0; Ti, 2·4; Al, 0·5; Cr, 21·0; balance, Ni.
(4) Nickel - chromium - cobalt-iron + small additions of molybdenum, tungsten, columbium and titanium.	Jessop and Company's G18*b*. C, 0·4; Si, 1·0; Ni, 13·0; Cr, 13·0; Co, 10·0; W, 2·5; Mo, 2·0; Nb, 3·0. Allegheny Ludlum Steel Corp., U.S.A. S816. C, 0·4; Ni, 20·0; Cr, 18·0; Mo, 4·0; W, 4·0; Cb, 3·0; Fe, 3·5; Co (balance), 45·0 approx.
(5) Cobalt - chromium with additions of molybdenum and tungsten.	Vitallium (U.S.A.). C, 0·2; Cr, 28·0; Mo, 6·0; Co (balance), 65·0 approx.

stages of the expansion; but experience with complex alloys has shown that an increase in size may multiply manufacturing difficulties unexpectedly, and therefore in the development of new alloys an early exploration of the influence of size should be made. It must be remembered also that, in all high-duty alloys for elevated temperatures, heat treatment plays an important part in creating the maximum endurance, and experiment is usually needed to determine the treatment appropriate in a particular case. In designs in which high-duty alloys are to be used, account must be taken of the modes of failure of these materials. The more resistant materials which usually have good ductility at atmospheric temperatures frequently show poor ductility under conditions of sustained stress and high temperature. This is because the mode of failure under these conditions is by intergranular fracture, and for this reason permissible deformations may appear to be unnecessarily small and the working stresses correspondingly low. Intergranular cracking may be caused by steep fluctuating temperature gradients, and tests show that different materials vary widely in their ability to withstand repetition of thermal shock.

The discussion was opened by Dr. W. G. Radley, who directed attention to the extensive use to which new materials have been put in tele-communications work, instancing the application of "Permalloy" alloys for the loading of submarine cables, of polythene for the insulation of high-frequency cables, and the ferrites for small transformer cores. Dr. A. T. Bowden, discussing Dr. Bailey's paper, said that austenitic steels must be used in gas turbines, and that these steels can be worked, up to their temperature of oxidation.

OBITUARIES

Prof. P. E. Newberry, O.B.E.

Percy Edward Newberry, who died at his home at Hascombe, near Godalming, on August 7, was the *doyen* of British Egyptologists. The youngest son of H. J. Newberry, of Ealing, he was born on April 23, 1869, and educated at King's College School and King's College, London. While still at school, at the age of fifteen, he came under the spell of Ancient Egypt, which was to dominate all the rest of his long life.

When only twenty-one, in 1890 (having already reprinted, in two volumes, essays by Carlyle), he became officer-in-charge of the newly founded Archæological Survey of the Egypt Exploration Fund (as it then was), a branch of the Fund's activities which was to prove highly fruitful in publishing accurate records of the already known rock-tombs of Egypt. His first work for the Survey was two volumes (1892–93) on the very important group of tombs at Beni Hasan; these were followed by two more (1893–94) on those of El-Bersheh; all the scenes and inscriptions were copied by him single-handed.

In 1895–1901 he was engaged on a survey of the Theban Necropolis, during which he cleared a number of tombs, and with R. de P. Tytus he excavated the Palace of Amenophis III there until 1902; in that year he joined the staff of the great "Catalogue Général of the Cairo Museum", contributing, as time went on, volumes on the contents of the tomb of Tuthmosis IV, on scarabs and scarab-shaped seals, and on funerary statuettes.

In 1900 he edited the papyri in the collection of Lord Amherst of Hackney and also much of the famous tomb of the Vezier Rekhmirê. His book on scarabs, which appeared in 1905, was for long the leading authority on the subject. He was the first holder of the Brunner chair of Egyptology in the University of Liverpool, to which he was elected in 1906, resigning in 1919 to make way for a younger man, T. Eric Peet. In 1908 he published a volume on the Timins Collection.

Much of Newberry's literary output was in the form of collaboration: together with, or in works by, Petrie, Garstang, Maspero, T. M. Davis, Lord Northampton, Lord Carnarvon, Howard Carter, Hall, Peet and others, he published much valuable work, especially on excavation and antiquities, history, ancient botany and art; and his contributions to various British and Continental journals embrace almost every branch of Egyptology.

During the First World War he took part in the national effort by undertaking the highly skilled work of gauge-making, somewhat to the detriment of his eyesight; later he became assistant secretary of the London and South-Eastern Region of the Ministry of National Service. In 1923 he was elected president of the Anthropological Section of the British Association; his address in that capacity, "Egypt as a Field of Anthropological Research", opened up new perspectives of investigation. During 1926–27 he was vice-president of the Royal Anthropological Institute. The winter of 1927–28 was devoted to an exploration of the Gebel Elba region of the Red Sea Province of the Sudan, from which he brought back a harvest of botanical and other specimens. Thereafter for four years (1929–33) he was professor of Ancient Egyptian history and archæology in the Fouad I University, Cairo. In 1933 the Saxon Academy of Sciences made him a corresponding member. Other distinctions were the O.B.E., in recognition of his war services, an honorary readership in Egyptian art in the University of Liverpool, and a vice-presidentship of the Egypt Exploration Society.

Throughout his career Newberry was an ardent researcher, and collected immense stores of notes on many aspects of ancient Egypt, bearing especially on history, early religion, botany and zoology. His zeal for amassing information (which led him to visit many out-of-the-way sites rarely visited by Egyptologists) outran his urge to publish the results; it is greatly to be hoped that other scholars will be able to make use of his rich material, which he was always

ready to put at the disposal of his colleagues. As a teacher he was admirable, and while professor at Cairo did a great deal in many ways for his Egyptian pupils, who regarded him with real affection. His industry was incessant, but did not interfere with his unusual degree of generosity and hospitality.

In 1907 he married Essie Winifred (who survives him), a daughter of William Johnston, of Bromborough, Cheshire. She assisted in the preservation of the necklaces and other pieces of jewellery found in the tomb of Tutankhamûn.

PATTISCOMBE GUNN

Dr. James Colvin

DR. J. COLVIN, senior lecturer in the Department of Inorganic and Physical Chemistry, University of Leeds, who died suddenly on September 5, at the age of forty-seven, had been a member of the staff of the Department since 1927. He was a graduate of the University of Liverpool and went to Leeds in 1925 to do research work under Prof. R. Whytlaw-Gray; he joined the academic staff at Leeds two years later.

Before 1939 Dr. Colvin worked on the kinetics of reactions in the solid state, particularly the dissociation of salt hydrates; during the War he was occupied with research for the Government, and more recently he returned to the study of salt hydrate decompositions. He was a brilliant teacher, and will be remembered with affection by generations of former students for his sympathetic understanding of their difficulties, academic and otherwise.

WE regret to announce the following deaths:

Mr. A. H. Hall, C.B., C.B.E., formerly chief superintendent of the Royal Aircraft Establishment, Farnborough, on September 11, aged seventy-three.

Prof. August Krogh, For.Mem.R.S., emeritus professor of zoophysiology in the University of Copenhagen, aged seventy-four.

NEWS and VIEWS

Frederick Ives Medal of the Optical Society of America: Dr. G. R. Harrison

THE Frederick Ives Medal for distinguished work in optics has been awarded by the Optical Society of America to Dr. George R. Harrison, dean of science in the Massachusetts Institute of Technology. Dr. Harrison, who is fifty-one, was born in San Diego, California, and graduated from Stanford University. After rising to become associate professor of physics at Stanford, he joined the Massachusetts Institute of Technology as professor of physics in 1930 and was appointed dean of the School of Science in 1942. As professor of physics, and during 1930–42 as director of the Research Laboratory of Physics at the Institute, Dr. Harrison has won wide recognition for his achievements in spectroscopy and studies of atomic structure, much of which was valuable in developments associated with the Second World War. He has made especially notable contributions in the fields of spectral line intensities, photometry and vacuum spectroscopy, and with his wide background of scientific research he is known as a leader in applying advances in modern physics to industrial development. Under his guidance the spectroscopy laboratory of the Institute has become an important centre of technological research and has produced tools of great value for investigations in modern physics. For his achievements in this field Dr. Harrison was in 1939 awarded the Rumford Medal of the American Academy of Arts and Sciences. During the War he was chief of the Optics Division of the Office of Scientific Research and Development, and later he became chief of the research section at General MacArthur's headquarters. In recognition of his services he was awarded the Medal of Freedom and the Presidential Medal for Merit.

A. J. Corda (1809–49)

BORN at Liberec in north-east Bohemia, August Josef Corda began a remarkable scientific career as a pharmacist's assistant. He attracted the attention of Prof. Krumbholz, who gave him a microscope and arranged for his further education. As early as 1826 Corda succeeded in germinating certain moss and fungal spores and made elaborate drawings of these cultivated cryptogams. He came into prominence for his medical work during the 1832 cholera epidemic, and this brought him to the notice of some German naturalists who gave him an opportunity to study cycads at Berlin. At the Breslau congress of doctors and naturalists in 1833, he gave an account of his work on *Cycas*, pointing to its links with higher cryptogams. Back in Bohemia, he was engaged to study the specialized algal and other flora of Karlsbad hot springs. Always fighting poverty, Corda's work was handicapped by his indifferent health; his main income was the stipend as curator of the Bohemian National Museum and the money he received from Count Kaspar Sternberg (president of the Museum Society) for his share in such tasks as examining fossils from the West Bohemian coal measures, described in Sternberg's "Flora der Vorwelt" (1837). Corda's most important work was "Icones Fungorum", printed in parts between 1837 and 1854, and thus completed by other botanists. Here, too, the most valuable feature was Corda's splendid illustrations. His ability to draw rapidly and accurately led to his being sent by some Bohemian patrons of science to Texas and elsewhere to collect specimens for the Museum. His ship, the *Victoria*, sank on the return voyage during a storm in the West Indies in September 1849, and Corda perished at the early age of forty.

Orientation of Lund Cathedral

A LECTURE on "The Orientation of the Cathedral of Lund", which was delivered by Hans Erlandsson at the Observatory of Lund on May 23, 1946, has been published by the Observatory in "Historical Notes and Papers", No. 21. In the donation letter of Canute, May 21, 1085, St. Lawrence was chosen as the patron saint of the cathedral at Lund, and the document of the consecration festival, September 1, 1145, says that the cathedral was built in honour of the Blessed Virgin Mary and Saint Lawrence, so that the name of St. Mary must be considered in dealing with the question of the orientation of the building. The late C. V. L. Charlier's investigations in 1900 suggested that the axis of the cathedral was

24·3° north of west and that the building was founded on the day of St. Lawrence. Observations made in April 1946 showed that an error of about 5° had occurred in Charlier's investigations and that this was due to the masses of iron tubes and cramp irons hidden in the floor and masonry. He had measured 24·3° in one place, and this agreed with St. Lawrence's day on August 10; but it has been found that about 18° north of west must be accepted as the true value. On August 22, 1085, the angle for sunset at the place was 17° 54′, and this date corresponds to the octave of the Assumption of the Virgin. An examination of the neighbourhood suggests that the building may have had some relation to an old pagan cult, the reasons for which are given towards the end of the lecture. In addition to the work on the cathedral, it is suggested that the church of the Dominicans at Lund had St. Mary Magdalene as patroness. The axis of this church is 34° north of west, and sunset on July 22, St. Mary Magdalene's day, is close to this angle.

A Package Testing and Advisory Service

THE Printing, Packaging and Allied Trades Research Association has recently extended the scope of its work by the provision of a Package Testing Station and advisory service at its new research centre at Leatherhead. The service is available both to members of the Association and to non-members on a fee-paying basis. The facilities available fall into four main categories. (1) The advisory service is designed to solve individual practical problems quickly and to supply information related to the many technical aspects of packaging; consultations may be made and, if required, laboratory research will be undertaken. (2) *Packaging Abstracts*, a monthly publication, hitherto restricted to flexible packages and packaging materials, has now been extended to cover the whole field of packaging, including bottles, cans, metal drums, wooden boxes, textile sacks, etc., in addition to fibreboard cartons and paper containers, and this journal has now been placed on general sale. (3) The packaging technical library contains many British and foreign books on packaging, and about two hundred periodicals and journals which are abstracted and form the basis of *Packaging Abstracts*. The library is open during 9.30 a.m.–5 p.m. (Mondays to Fridays) for *bona fide* inquirers. (4) The package testing station provides three groups of tests which enable manufacturers and users to select the design or the material for a pack so as to provide the optimum protection to the packed goods against all the hazards to which they are likely to be subjected. The first group of tests is that concerned with the mechanical strength of the package —a drum test designed to simulate general handling, an inclined plane tester which reproduces the type of shock encountered in shunting, and various types of drop test for determining tensile, burst and tear strengths, etc. The second group is concerned with the resistance of packages to atmospheric conditions, and materials are tested for their permeability to water vapour, gases and liquids (including water and oils). The third group of tests covers the protection afforded by the package to attack by insects and moulds, particularly for goods exported to tropical countries. In addition, storage rooms have been installed where the climatic conditions may be controlled to imitate those prevailing in most parts of the world. All inquiries should be addressed to Patra House, Randall Road, Leatherhead, Surrey.

Management Studies

BASED on the findings of the Urwick Committee which reported in 1947, the British Institute of Management and the Ministry of Education have now submitted details of the schemes which they are prepared to approve at further educational institutions for the award of intermediate certificates and of diplomas in management studies. Students for the intermediate certificate must have reached the minimum age of twenty-three years before completing the course and will be required to attend a course of directed study for three years concurrently with commercial or industrial employment. For the diplomas, courses will either be general or specialized and may be taken by students who have already obtained an intermediate certificate or are qualified to pursue more advanced studies in management subjects; they must have reached the minimum age of twenty-five years before completing the course. Diploma courses should normally provide for two years directed study concurrently with commercial or industrial employment. Where the experience and age of the students merit special consideration, full-time courses or other alternative arrangements may be approved. Further details of the courses may be obtained from Rules 116 (June 1949) of the Ministry of Education, H.M. Stationery Office, price 2*d*. net.

Bird Preservation

BESIDES those activities already in progress, the annual report of the British Section of the International Committee for Bird Preservation describes the formation of an International Wildfowl Research Institute. Accommodation for the new Institute has been provided at the Zoological Museum, Tring, and Dr. E. Hindle, scientific director of the Zoological Society of London, has been appointed honorary director. The Institute will be the international centre for existing and projected research into matters affecting wildfowl, and, it is hoped, will also build up study collections (including specimens, photographs, slides and films), which could be used for exhibitions designed to arouse a wider interest in wildfowl. Other items in the report include information collected by wildfowl counts during 1947–48; a list of counties which have agreed to give complete protection to the barnacle goose (*Branta leucopsis*) for a period of five years; an account of the action taken to prevent the netting of geese on the Wash at Holbeach and details of the ringing of wild duck being carried out at Orielton, Abbotsbury and Slimbridge. In the report there is also a full description of the British Wildfowl Exhibition which was held in London, and an account of various conferences which were held with other European members of the International Committee for Bird Preservation.

Spore Discharge in *Lycoperdon*

AN interesting study of spore discharge in *Lycoperdon perlatum* has been made by P. H. Gregory, using ultra-high-speed Schlieren cinematography (*Trans. Brit. Mycol. Soc.*, **32**, Pt. 1, 11; 1949). Spore discharge is brought about by raindrops of 1 mm. diameter or more falling on the flattened endoperidium. The puff of spores thereby induced reaches a height of 1 cm. approximately one hundredth of a second after impact. Velocities of the spores on emergence are in the order of 100 cm./sec. The film is run at a speed of 600–1,770 pictures per second, and a time-base controlled by tuning fork is marked

on the edge of the film. This fascinating method of approach might be applied to many other similar problems.

Geophysical Conference in South Africa

A THREE-DAY conference on geophysical subjects, organised by the Bernard Price Institute of Geophysical Research, of the University of the Witwatersrand, was held in July in Johannesburg. It was attended by some seventy-five scientific workers, mainly from the Witwatersrand and Pretoria, but including visitors from universities and other organisations in the Cape and Natal, and one or two from Rhodesia and the Belgian Congo. Thirty-eight papers were presented in two sessions running simultaneously. These covered the fields of meteorology, seismology, terrestrial magnetism, lightning, the ionosphere, gravity and geophysical prospecting methods, the last of which aroused much interest. Some interesting papers were read on behalf of members of the staff of the Department of Terrestrial Electricity and Magnetism of the Carnegie Institution of Washington. All these papers dealt with unpublished, or recently published, work by the authors, and some were accompanied by demonstrations of instruments, equipment, etc. The convention gave a good picture of the flourishing state of geophysical science in southern Africa, and of the considerable interest taken in the application of it to practical problems. Its success has led to the intention of repeating the venture in a few years time.

Pavlov Centenary Celebrations

A SERIES of lectures in celebration of the hundredth anniversary of the birth of Ivan Pavlov is being organised by the Pavlov Centenary Committee of the Society for Cultural Relations between the Peoples of the British Commonwealth and the U.S.S.R. On October 6 Dr. A. S. McPherson will read a paper entitled "Recent Advances in the Study of Conditioned Reflexes", and on October 13 Dr. B. H. Kirman will speak on "The Application of Conditioned Reflexes to Psychiatry", both lectures to be delivered at 7.30 p.m. at 14 Kensington Square, London, W.8. Mr. J. G. Crowther will speak on "Pavlov, Scientist and Man: his Place in the History of Civilization" at 7.30 p.m. on November 3 at the University of London Institute of Education, Malet Street, W.C.1. The celebrations will also include performances (date and place to be announced later) of a new Soviet biographical film, "Academician Pavlov", and a film "Mechanism of the Brain", made by Pudovkin in 1925. Series tickets costing 10*s*. (non-members 12*s*. 6*d*.) and single tickets (2*s*. 6*d*. and 3*s*.) can be obtained from the Secretary, S.C.R. Science Section, 14 Kensington Square, London, W.8, to whom all inquiries should be addressed.

Operational Research: Meetings at Manchester

THE Manchester Joint Research Council will be holding a series of six meetings devoted to operational research, to be held on Fridays at fortnightly intervals, at which prominent authorities will speak and the problems of applying the technique of war-time operational research to peace-time conditions in British industry will be discussed; the final meeting will be an open forum at which Sir E. Raymond Streat, assisted by Prof. P. M. S. Blackett, will sum up. The meetings will be held in the board room of the Manchester Chamber of Commerce, Ship Canal House, King Street, Manchester 2, at 11.30 a.m. during September 30–December 9, and the fee for the series is 30*s*. Further details can be obtained from the joint honorary secretaries of the Council at the above address.

International Conference on Building Documentation

AN international conference on building documentation will take place during October 6–15, 1949, in the Palais des Nations, Geneva, under the auspices of the United Nations Economic Commission for Europe at the request of its Housing Sub-Committee. Mr. R. Fitzmaurice, chairman of the E.C.E. Housing Sub-Committee, will be in the chair. Governments, international organisations and United Nations specialized agencies have been invited to send delegations of technical experts and of all the different groups of users of building documentation. The programme of the conference will deal with building documentation, defined as the recording, organisation and dissemination of information relating to building in all its aspects, and for this purpose the work will be divided between seven working parties which will consider respectively the scope and nature of the abstracts; organisation of an international abstracting service; adoption and adaptation of the universal decimal classification; filing systems; recommendations for building publications; official building publications; and terminology. The aim of the conference is to propose steps to be taken in order to promote efficient building documentation and, thereby, better building at less cost; in particular, the delegates will examine the need for an International Building Documentation Office and for an International Union of Building Documentation Committees, and the conditions under which such bodies could be set up to continue international co-operation. All recommendations agreed to at the conference will be sent to the Housing Sub-Committee so that the latter may forward them to Governments for implementation in their respective countries. All communications should be addressed to the Conference on Building Documentation, Economic Commission for Europe, Palais des Nations, Room 278, Geneva, Switzerland.

Announcements

MR. H. M. GARNER has been appointed chief scientist to the Ministry of Supply in succession to Sir Ben Lockspeiser. For the last three years Mr. Garner has been principal director of scientific research (air) in the Ministry of Supply.

DR. WILLIAM F. HESTER, formerly director of insecticide and fungicide research at the Rohm and Haas Co., Philadelphia, Pa., has been appointed administrator of the thirteen fellowships of Koppers Co., Inc., at the Mellon Institute of Industrial Research, University of Pittsburgh. In his new position, Dr. Hester will be responsible for the research and development being conducted by ninety-eight scientific workers and their assistants at the Mellon Institute.

A LECTURE course on "Room Acoustics", arranged by the Acoustics Group of the Physical Society, will be given by Dr. R. H. Bolt on September 29, 30, October 3, 4, 5 and 7. These lectures are at 5 p.m. at the Royal Institution, Albemarle Street, London, W.1, and admission is by ticket obtainable from the Secretaries of the Acoustics Group of the Physical Society, 1 Lowther Gardens, Prince Consort Road, London, S.W.7.

PHYSICAL APPROACH TO THE STUDY OF BIOLOGICAL SYSTEMS

ONE of the many valuable features of the Institute of Physics Convention held in Buxton during May 19–21 was the joint meeting of the X-ray Analysis and Electron Microscopy Groups of the Institute for the purpose of exploring the physical approach to the study of biological systems. The discussion was opened by Prof. J. T. Randall (King's College, London), who was followed by Dr. I. M. Dawson (National Institute for Medical Research, Hampstead), Dr. R. Reed (University of Leeds), Dr. M. Perutz (University of Cambridge) and Mrs. D. M. Hodgkin (University Museum, Oxford).

It is not uncommon for scientific workers entering some new field of work such as biophysics to ignore or neglect much work and endeavour of great importance carried out by men of other disciplines than their own. Biologists have for hundreds of years been among the most conspicuous users of microscopes. The title of the symposium reported in these notes is, however, justified by the notable advances recently made by physicists in the development of new or improved instruments and methods of approach. X-ray diffraction, phase-contrast microscopy, reflecting microscopes and, not least, the electron microscope, have all opened up wide—and often quite new—fields of research in biology as well as in other subjects.

In his introduction to the symposium, Prof. J. T. Randall chose to speak of certain problems not specifically dealt with by other contributors, emphasizing how useful is the manifold approach to complex problems, particularly in the biophysical field, where the external distinction of form, and perhaps of crystallinity, merge into the less definite features of micro-morphology, cytology, and its biochemical interpretations. As an example, Prof. Randall gave the work of M. B. McEwan and D. L. Mould on the properties of bentonite gels in relation to long-distance forces. In order to understand these systems, it has been necessary not only to devise methods of measuring the rigidity, but also to study birefringence, X-ray and optical scattering, in addition to the measurement of particle-size in the electron microscope.

The application of X-ray diffraction methods to liquids, solutions and colloid systems has a history[1] almost as long as that of X-ray crystallography proper, and the recent work of Riley[2] and Riley and Herbert[3] on solutions of hæmoglobin and egg albumen shows that valuable if limited information about molecular size, shape and aggregation may be obtained by the use of the low-angle scattering technique earlier applied with such success by Bernal and Fankuchen[4] to tobacco mosaic virus paracrystals. There is still too great a tendency in work on solutions to avoid the tedious but sometimes necessary procedure of deducing the radial distribution function of scattering matter by the method of Fourier inversion. Oster[5] has recently pointed out the formal similarities of the theories of X-ray and light scattering of solutions, and we may expect an increasing use of the two methods in the study of size, shape and interaction of large molecules.

There has also been increasing interest in the application of other optical methods to the study of biological material. This is evident in the ultra-violet[6] and infra-red[7] fields, where the advantages of the reflecting microscope[8,9] are bound to be exploited, especially with living material. Dichroism, microscopy and absorption at low temperatures[10,11] are also aspects of biophysical study likely to develop.

The discussion on the use of the electron microscope in the study of biological material revealed that a very wide range of problems is being studied in Great Britain. The paper by Dr. R. Reed, of Leeds, reviewed work by Wyckoff, Cosslett and others on crystalline viruses and the relation of this work to that of the X-ray crystallographers. The limit of resolution in the electron microscope has so far restricted such studies to the viruses of higher molecular weight.

Dr. Reed also referred to the relationship between globular and fibrous proteins, a relationship which has been brought very much to the forefront by recent studies in Great Britain (at Leeds) and in the United States (Wyckoff, Porter and Hall). It is becoming clear that many of (possibly all) the fibrous proteins can exist in a unit, corpuscular form which has the property of forming long fibres by linear aggregation. Actin, tropomyosin, fibrinogen-fibrin, and certain collagenous fibrils should be mentioned in this connexion. This important question was later discussed by Perutz.

Dr. Dawson referred particularly to the study of individual virus particles and the wide variation in structure which may exist; the larger viruses, such as vaccinia, may be more akin to bacteria and the smaller ones to protein molecules. Such generalizations, however, may be swept away by our growing knowledge of the smaller units. The importance of enzymic digestion in the elucidation of virus structure was also brought out in Dr. Dawson's paper, and mention was made of the use of trypsin, pepsin, desoxyribonuclease, collagenase and lecithinase.

The work of Elford and Dawson on the multiplication of virus particles within the host cell was also discussed. Hirst's technique for the separation of virus particles of the influenza group by means of adsorption and elution from the surface of red blood cells has been adapted to the electron microscope by the use of laked cells in order to achieve a sufficiently thin subject for examination. The examination of a strain of influenza virus such as *PR8* at various stages of the development cycle has given suggestive evidence concerning multiplication by binary fission.

Prof. Randall referred to work on tissue culture cells, nuclear membranes and spermatozoa, and stressed that, as the electron microscopist advances from the study of single particles to an organised or differentiated biological structure, the need for specific 'electron' stains comparable with the well-known stains used in visible microscopy is becoming an urgent problem, without which electron microscopy cannot hope to share in the development of cytochemistry. While the technique of tissue culture provides thin, flat cells for examination, it is also clear that more reliable sectioning techniques are required.

Dr. M. Perutz gave an appropriate and clear survey of recent work on the structure of proteins as one of the most interesting meeting points of X-ray analysis and electron microscopy. After some reference to the X-ray work of Astbury on protein fibres produced by the living cell, and to the conclusion that these fibres consist of bundles of polypeptide chains running parallel to the fibre direction, Dr. Perutz went on to discuss the evidence of electron microscopy. Contrary to the older ideas of micelles, there always

seems to be at least one level of organisation between the polypeptide chain and the macroscopic fibre. This level consists of microfibrils the thickness of which varies between 100 A. and 1,000 A. in different proteins; and the microfibrils in turn often appear to consist of assemblies of globular particles; sometimes a simple string of beads; sometimes a more complex pattern as in the paramyosin of clam muscle. The investigation of clam muscle is a striking example of the combined approach of X-ray analysis and electron microscopy. The X-ray pictures of Bear[12] show the typical α-keratin pattern in addition to a low-angle pattern which is resolved into a series of distinct spots. The low-angle pattern can be interpreted in terms of hexagonal array of globular particles of 150 A. diameter, which corresponds exactly with the electron microscope pictures of Hall, Jakus and Schmitt[13]. Another protein, tropomyosin, can undergo a reversible transformation from fibrous to what may prove to be a corpuscular state. The work of Perutz and Kendrew on hæmoglobin and myoglobin[14], both typical corpuscular proteins which have no tendency towards fibre formation in the native state, shows these proteins to consist of bundles of polypeptide chains. It appears that the chains are folded in the α-keratin configuration. Mrs. Hodgkin[15] has recently found evidence of such chain structures in the small peptide gramicidin. Dr. Perutz stressed the importance of further knowledge of the α-keratin structure as basic to the future study of hæmoglobin and myoglobin; this knowledge is not likely to come by model-building alone; more experimental data are required. The recent studies by Elliot, Ambrose and Temple[16] with polarized infra-red radiation on proteins of the α-keratin type have revealed a striking dichroism. Absorption is much stronger (in the neighbourhood of 3 μ) parallel to the fibre direction than at right angles to it. This indicates that the CO—NH bonds are oriented preferentially and parallel to the fibre axis. This observation confirms the old contention that folds in the α-keratin chain must be held together by hydrogen bonds located within each chain.

The use of the reflecting microscope in such studies receives further emphasis from the work of Barer, Jope and Perutz on the ultra-violet absorption of single hæmoglobin and myoglobin crystals. The pronounced dichroic effect in the absorption of the hæm group at 400 mμ shows that this ring is orientated with its plane normal to the *a*-axis of the crystal. The second absorption band shows a maximum dichroic effect at 290 mμ, a region associated with the indol group of tryptophan. Like hæm, this ring system would be expected to show absorption only when the electric vector is parallel to the plane of the ring. The dichroic effect thus indicates that the plane of the indol group is normal to the *a*-axis. X-ray data show the polypeptide chains to be parallel to *a*. Thus, the planes of both hæm and indol rings are normal to the polypeptide chain direction. In tobacco mosaic virus the indol rings are normal to the length of the virus particle.

Dr. Hodgkin stressed the importance of obtaining new information about the region of size to which both X-ray diffraction and the method of electron microscopy might apply; and particularly, the region just below the limit of size where electron micrographs at present show clear detail, say 50 A. or so. X-ray data indicate structure within particles such as the bushy stunt or turnip yellow virus which might be of this order of magnitude. Dr. Hodgkin also discussed the interrelation between information derived from both methods as applied to tobacco necrosis protein.

J. T. RANDALL

[1] See, for example, Randall, J. T., "Diffraction of X-rays by Amorphous Solids and Liquids" (London: Chapman and Hall, 1934).
[2] Riley, D. P., *Brit. Sci. News* (in the press).
[3] Riley, D. P., and Herbert, D., *Biochim. et Biophys. Acta* (in the press).
[4] Bernal and Fankuchen, *J. Gen. Physiol.*, **25**, 111 (1941).
[5] Oster, *Rec. Trav. Chim. Pays-Bas* (in the press).
[6] See, for example, Caspersson in Society of Experimental Biology, Nucleic Acid Symposium (Cambridge, 1947).
[7] See *Proc. Roy. Soc.*, B, **136**, XIV (1949).
[8] Burch, *Proc. Phys. Soc. Lond.*, **59**, 41 (1947).
[9] Seeds and Wilkins, *Nature*, **164**, 228 (1949).
[10] Brown and Randall, *Nature*, **163**, 209 (1949).
[11] Loofbourow, Sinsheimer and Scott, *Science*, **107**, 302 (1948).
[12] Bear, *J. Amer. Chem. Soc.*, **66**, 2043 (1944).
[13] Hall, Jakus and Schmitt, *J. App. Phys.*, **8**, 459 (1945).
[14] Perutz and Kendrew in Barcroft Memorial Volume "Hæmoglobin", 161 (Butterworth, 1949).
[15] Hodgkin and Schmidt, reported in *J. Sci. Instr.*, **26**, 283 (1949).
[16] Elliot, Ambrose and Temple, *Nature*, **163**, 859 (1949). See also Astbury, *Nature*, **164**, 439 (1949) and Sutherland and Darmon, *Nature*, **164**, 440 (1949).

PREPARATION AND INSECTICIDAL ACTION OF *BIS* (*BIS*-DIMETHYLAMINO)-PHOSPHONOUS ANHYDRIDE

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IT has been reported by Schrader[1,2] and other German workers that certain organo-phosphorous compounds have strong insecticidal properties. They act as contact insecticides, but also, in a less familiar manner, as 'systemic' insecticides, that is, they are absorbed by the roots or the leaves of a plant and render it toxic. The effect may be very persistent and this mode of action would be of considerable economic interest were it not for the fact that, with compounds tested to date, the treated plants are also toxic to mammals.

In order that biological tests may be definitive, it is necessary to work with pure materials. This is especially so with the synthetic organo-phosphorous compounds, which differ widely in insecticidal activity. The *bis* (*bis*-dimethylamino)-phosphonous anhydride used in the present investigation has been prepared with great care, and the steady boiling point and satisfactory analysis suggest that the material was pure.

Preparation. Purified starting materials were employed and the intermediate compounds were all fractionated carefully one or more times through a 24-in. column packed with glass helices and with a variable take-off stillhead. The method of synthesis used was based on that outlined by Schrader[2] and was briefly as follows:

Methylaminehydrochloride and excess phosphorus oxychloride were refluxed for 20 hours and fractionated to give dimethylamino-dichlorophosphine oxide (I), NMe_2POCl_2 (b.p. 88°/18 mm.; 94 per cent yield). Treatment of I (1 mol.) with methylamine (2 mol.) in ether at room temperature yielded *bis* (dimethylamino)-chlorophosphine oxide (II), $(NMe_2)_2POCl$

(b.p. 102°/6 mm.; 84 per cent yield). Ethyl *bis* (dimethylamino)-phosphonite (III), $(NMe_2)_2PO(OEt)$, was made by reaction of II with an equimolecular amount of sodium ethoxide in alcohol (b.p. 93·5°/8 mm.; 88 per cent yield). When II and III were heated together in equimolecular amounts in boiling xylene for 20 hours, ethyl chloride was evolved and, after fractionation, *bis* (*bis*-dimethylamino)-phosphonous anhydride, $(NMe_2)_2PO.O.PO(NMe_2)_2$, was obtained in 81 per cent yield as a colourless, almost odourless liquid, b.p. 98°/0·002 mm., 102°/0·003 mm., or 106°/0·004 mm. Analysis gave C, 33·9; H, 8·5 and N, 19·8, while the formula $C_8H_{24}N_4P_2O_3$ requires C, 33·6; H, 8·4 and N, 19·6 per cent.

Biological tests with Aphis fabæ. For the biological tests the material, prepared as above, was diluted to a 10 per cent v/v solution in distilled water and stored to be diluted further as required.

Broad beans were infested with *Aphis fabæ* and kept in a greenhouse at 16–26° C. The relative humidity and light conditions varied greatly. The results of the observations made to date may be summarized as follows.

Contact action. The day after the plants have been dipped in a 0·05 per cent v/v solution of the insecticide containing 0·1 per cent 'Teepol' as a wetting agent, the colonies of aphids are very much reduced in numbers. The young die first; but the plant is not entirely free from aphids for about three or four days. A 0·1 per cent solution acts rather more quickly and a 0·025 per cent solution more slowly. The leaves retain their toxicity to new infestations of aphids for about three days only. The action is slow on aphids arriving on the third day and the colonies take about six days to die out. Necrotic areas develop on the leaves after about fourteen days with concentrations of 0·05 per cent and more. Teepol' alone, at the stated concentration, is somewhat toxic to aphids, but the colonies survive and no necrotic areas develop on the plants.

Absorption from the roots. When applied to potted plants about six inches high in quantities ranging from 0·2 to 0·05 c.c. per 400 gm. soil, there is little apparent effect for three to five days, depending on the dose, but all aphids are killed in six to eight days. The plants are still toxic three weeks later, but at doses of 0·05 c.c./400 gm. soil and more, necrotic areas develop after about ten days.

In culture solutions, a 0·5 per cent concentration of insecticide frees the plant from all aphids in twenty-four hours, but necrotic areas develop in five days. A 0·05 per cent solution produces the same effect in four days, and necrotic areas appear about the fourteenth day. A 0·005 per cent solution kills the aphids in about nine days, and necrotic areas only begin to appear about the twentieth day. At this time the plants are still toxic to aphids.

If the plants are allowed to absorb 6–10 c.c. of a culture solution containing 0·1 per cent v/v of the insecticide, they remain toxic to aphids for at least twenty-one days. They develop necrotic areas after about fourteen days.

Concentration in the plant necessary to kill the aphids. A dose of 1 c.c. of a 0·1 per cent v/v solution gives a 99 per cent kill of aphids in two days when absorbed totally and rapidly (about three hours) by the cut main root of a plant weighing 10–15 gm. If it is assumed that the insecticide is absorbed and translocated unchanged, this dose would represent a concentration of insecticide of about 60–100 mgm./kilo in the plant tissue. When the absorption is slower (several days), the kill is delayed and may be incomplete.

Absorption from the leaves. When 0·5 c.c. of a 0·2 per cent v/v solution of the insecticide is applied to the upper surface of a pair of bean leaves, the aphids feeding on the lower surface are killed, but on the other parts of the plant they are unaffected. Absorption and translocation does not follow applications made to the undersurfaces of the leaves, either.

Mode of action on the insects. It is reasonable to suppose that the insecticide is absorbed by the roots and carried in the transpiration stream, and that the sap on which the insects feed becomes poisoned. Experiments in which the transpiration of certain leaves is depressed by enclosing them in a saturated atmosphere tend to confirm this. There is no evidence with this material that any vapour action is involved.

Tests against other insects. The material does not appear to be highly toxic to the stored-product insects *Ptinus tectus* and *Tribolium confusum*, which have been placed on surfaces treated with it. In this respect it is less toxic than O, O-diethyl O-*p*-nitrophenyl thiophosphate (*E*605).

It is hoped to publish a more detailed account of this work at a later date.

[1] Martin, H., and Shaw, H. Developments in methods and materials for the control of plant pests and diseases in Germany. Rept. No. 1095. British Intelligence Objectives Sub-Committee. (London, 1948.)

[2] Schrader, G. Rept. No. 714, *ibid.* (1948.)

PROGRESS OF CANCER RESEARCH

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THE British Empire Cancer Campaign (11 Grosvenor Crescent, S.W.1) has now supported cancer research for a quarter of a century. The twenty-sixth annual report, edited by Sir Heneage Ogilvie, is a weighty volume of 320 pages where the reader will find that the Campaign finances, wholly or in part, nine centres of research in London and twenty-eight in the provinces, and co-ordinates, or is affiliated to, other centres in Canada, Australia, New Zealand and South Africa; that the Campaign's income was more than £300,000 in 1948, and that it is administered by more than a score of committees and sub-committees. The Campaign supports three types of investigation and development, namely, radiological, clinical, and a composite group, mainly biochemical.

The accompanying table shows the subject and number of investigations which are described in the report:

Radiology; biophysics	26
Carcinogens; carcinogenesis	12
Chemotherapy	8
Biochemical	7
Hormones	6
Clinical (excluding the Clinical Committee Report)	5
Pathology	4
Genetics; mutation	3
Virus tumours	3
Cytology	2
Tissue culture	2
Social incidence	2
Effect of diet on growth of tumours	1
Milk factor for mouse mammary carcinoma	1

The ever-increasing prominence of physics-inspired research and development expresses not only the

urgent needs of the therapy of cancer, but also the remarkable evolution of physical and optical instruments, such as the synchrotron, the phase-contrast and ultra-violet and electron microscope, Geiger counters and the infra-red spectrometer.

With regard to researches of biochemical type, space will allow something to be said about only a few lines of advance. Sir Ernest Kennaway and his collaborators are compiling a bibliography of carcinogenic compounds and the tumours produced by them. The literature of the most sensational discovery in cancer work now has an author index referring to more than three thousand papers, which have appeared in a quite overwhelming number of journals (340) in several languages, representing the growth of the subject up to 1947. (The first paper on pure carcinogenic compounds quietly made its appearance in 1930 under the title, "Further Experiments on Cancer Producing Substances" by E. L. Kennaway, *Biochem. J.*, **24**, 497 ; 1930).

Sir Ernest is continuing the statistical studies from the Registrar General's reports on cancer of the lip and other tissues (see below).

New carcinogens are still being added to a long catalogue of more than 300. These latest compounds, discovered by Haddow and colleagues, are, in fact, the notorious nitrogen mustards ; for example, methyldi(2-chloroethyl) amine, which produces lung carcinoma, and lympho-sarcoma and sarcoma at the site of injection in mice ; in the aromatic series, NN-di(2-chloroethyl)-β-naphthylamine induces sarcoma at the site of injection in rats. These examples again illustrate Haddow's original postulate that carcinogenic and inhibitory potentialities are due to a common property of the molecule.

Carr and Harris have been working out the technique for obtaining Rous virus in a purified condition, when it can be put to further analysis by the electron microscope and by chemical and serological methods. Their very active preparations show that only 10^{-12} gm. nitrogen is present in a tumour-producing dose.

An investigation, attractive in more ways than one, has been pursued by Horning and George, who spent three months at the cosmic ray laboratory on the Jungfraujoch at 12,000 ft. ; Figge, in the United States, had claimed that intensification of the cosmic ray incidence, by favourable screening with lead sheet, stimulated the carcinogenic effect of methylcholanthrene in mice. At 12,000 ft. the cosmic ray showers are substantially improved by a factor of five. However, the Figge effect of cosmic rays on the carcinogenic process could not be confirmed.

Of particular interest is the work of Ludford, who has used the phase-contrast and ultra-violet microscope to some purpose in the study of the widely different cytological structures present in even a small fragment of tumour, and of the nucleotide characteristics of rapidly growing and regressing tumour cells.

At Leeds, Passey and co-workers are making progress in the investigation of the transmissible milk factor for mouse mammary carcinoma. The agent will survive extraction of fat in a Soxhlet with petrol ether, and its activity is paralleled by electron microscope estimations of particle yield. Of great interest is the discovery that the mouse breast cancers initiated by treatment with methylcholanthrene show no evidence of containing the milk factor, provided the process is carried out in a strain of mice which are naturally free from milk factor, that is, in low breast cancer strains, thus showing that breast cancers are clearly of two types.

Clinical work is represented chiefly by statistical surveys and therapeutic trials. The task of collecting basic data concerning the natural history of various forms of cancer is a formidable one, involving the study of incidence, and changing incidence in relation to social habits, racial, economic and occupational factors. These data are being added to year by year, and in the present report figures relating to cancer of skin and lip and of the uterus are given.

A fascinating analysis of the mortality, between 1911 and 1944, of cancer of the skin, and especially cancer of the lip among the males of three occupational groups (agricultural, mining, professional), representing a population of more than 2½ million, shows that while the agricultural worker is about three times more likely to die of cancer of some part of the skin than the professional man, he is twelve times more likely to die of cancer of the lip. It may be supposed that greater exposure to sunlight in the case of the agricultural worker increases his susceptibility ; but the similar incidence among miners in whom such exposure is largely absent shows that some other factor is involved. The low mortality among professional men may not, however, be related to morbidity in the same ratios as in the other occupations, earlier and therefore more successful treatment preventing many deaths among them. Material from many parts of the world indicates that Jewish women are about three times less likely to develop uterine cancer than are non-Jewish women. This is apparently related to the Jewish practice of abstention from intercourse during the first twelve days of the menstrual cycle. The incidence of uterine cancer increases in both single and married women with descent in the economic scale.

In at least six centres concerted efforts are being made to obtain precise evidence concerning the value of sex hormones in the treatment of mammary carcinoma. The most ambitious of these efforts is that in which the British Columbia Cancer Institute is taking part as one out of forty-eight clinics in Canada and the United States. Six different œstrogens, natural and synthetic, and testosterone propionate in dose schedules ranging from 75 to 600 mgm. per week are being tested.

At several centres measurements of 17-ketosteroid and œstrogen excretion before, during and after such treatment are being carried out, and at Guy's Hospital this work is being done concurrently with a long-term survey of cases of mastitis, in which it is hoped to establish more precisely the relationship between mastitis and breast cancer, an issue which is still controversial after a century of study by clinicians and pathologists.

At St. Bartholomew's Hospital the differential excretion of individual 17-ketosteroids separated by chromatography is being studied with special reference to prostatic disease. The abnormal excretion of ætiocholanolone, which had been previously reported by Dobriner as occurring particularly in malignant disease, has now been shown to occur in cases of benign prostatic hypertrophy. In cases of prostatic cancer, the pattern of excretion changes under œstrogen therapy. This is being fully investigated, together with the changes in wave form obtained by polarographic examination of serum.

Other studies include detailed analyses of nearly four hundred cases of ovarian cancer, and of more than a hundred of cancer of the vulva, and several

series reporting the results over a number of years of surgical and X-ray treatment of cancer of uterus and breast. Million-volt therapy appears to have no inherent advantages over 200 kV. therapy, though for technical reasons it may sometimes be more efficient.

On the physical side the report shows that considerable effort is being made in a number of centres to provide the facilities and equipment necessary for the clinical use of radioactive isotopes, which have been available from the Medical Research Council for therapeutic purposes since September 1948. Among the new instruments for detection and measurement of radioactive isotopes on which work is being carried out is the scintillation counter. Several centres report investigations on the possibilities of cobalt-60 as a replacement for radium in various therapeutic applications.

A survey is given in the report from St. Bartholomew's Hospital on the clinical results with the million-volt plant over the last eleven years. Measurements that have been made on very high energy X-radiations are reported from the Royal Cancer Hospital, where a 30-million volt synchrotron is now being installed.

Three centres report on the investigations on dosage and protection requirements with 10-gm. radium units. Of particular interest is the report from the Leeds General Infirmary, where the shielding of the unit is provided by uranium metal.

Critical studies of problems in dosage measurement are reported from several centres, particularly with regard to the energy absorption occurring in or near bone. Geometrical methods of estimation of dosage within patients appear to be giving way to some extent to methods of direct measurement on the patient during treatment, and the design and construction of various instruments for this purpose are reported on.

The chemical effects of radiation are being further investigated. A report from the Christie Hospital and Holt Radium Institute describes continued work on 'protection' phenomena, and at the Royal Victoria Infirmary, Newcastle, further investigations have been carried out to test the free radical theory. As a result of this latter study it has been possible to develop methods of dosage measurement based on chemical effects which may be of considerable importance in dosimetry studies with radioactive isotopes.

Related to these experiments on the chemical effects of radiation, a report from Mount Vernon Hospital states that it has been demonstrated that the sensitivity of the broad bean root to X-radiation is very dependent on the oxygen concentration of the water in which the root is immersed.

In the field of experimental radiology, reports on whole body irradiation of mice and localized irradiation of rat tumours show that in each case the effects of the radiation depend on the protein diet of the animals.

Possibilities of the therapeutic applications of microwaves of wave-lengths 1–100 cm. are reported from two centres. The work done so far has been on the absorption and dielectric properties of water and various types of tissue.

The report from the Dominion X-Ray and Radium Laboratory, Christchurch, gives an interesting account of the development of a radio-physical advisory centre in New Zealand, and of the particular problems involved in such a country with a small and relatively scattered population.

INSTITUTION OF ELECTRONICS (N.W. BRANCH)

FOURTH ANNUAL EXHIBITION

AFTER a modest beginning, the exhibition of the Institution of Electronics (N.W. Branch) now appears to be firmly established as an annual affair. Each succeeding year has seen a widening in scope and variety of the apparatus exhibited, until this year there were sixteen firms represented, the floor space occupied being considerably greater than at any of the previous exhibitions. On show this year, in addition to the standard measuring and communications apparatus, were several instruments of improved design, and others in which new features were incorporated.

Dawe Instruments, Ltd., showed a Swiss product which is now being manufactured in Great Britain under licence. The apparatus measures the moisture content of warps and fabrics and affords a continuous drying control over the entire width of the material. The measuring principle is based on the fact that the magnitude of the electrostatic charges which develop on fibrous material in motion depends to a large extent upon the degree of moisture of the material. These charges are collected by means of small insulated concave riders, which act as brushes, and are transferred to a measuring instrument of new design which is capable of detecting extremely small electrostatic charges.

A high-power stroboscope for use in the examination of heavy machinery operating at speeds within the range 20–3,000 r.p.m. was also shown by the same firm. The instrument, which can be operated remotely, has a variable-phase control so that any required part of the machine can be examined.

W. Edwards and Co., Ltd., showed a new relay for vacuum control in which variation in conductivity of the gas with pressure causes a long heated filament to operate electrical contacts. The ranges of pressure are between 0·001 and 10·0 mm. mercury, with differential according to requirements. New types of rotary pumps and a range of oil diffusion pumps were also exhibited.

A novel feature demonstrated by Everett Edgcumbe and Co., Ltd., was a valve demonstration panel for educational purposes. It is designed for laboratory use to facilitate the plotting of valve characteristics with direct potentials, and comprises an A.C. power pack with voltage controllers, voltmeters and ammeters in each electrode circuit. A mimic diagram embraces the controllers, indicators and external terminals.

Ferranti, Ltd., showed two new instruments: a cold-cathode voltage stabilizer having a running voltage of 60·5 volts with a current-range from 2·5 m.amp. to the unusually low value of 120 μamp., and an electronic impulse counter. In the counter, a photoelectric cell amplifier is connected either directly or by way of a frequency-dividing network to a mechanical recording counter. Light flashes at rates of up to 8,000 per minute can be accurately observed.

Marconi Instruments, Ltd., demonstrated their six-channel electroencephalograph, which has proved reliable over a period of three years. The direct-coupled mains amplifiers have a gain of 10^6 with less than 2 per cent distortion on full gain. The same firm was one of several exhibiting meters for the determination of the moisture content of timber and

of cereals. Percentage moisture content of timber is obtained by relating it to electrical conductivity by a direct-current method. Four needle electrodes are designed to penetrate the specimen to a depth of approximately 5 mm., and the conductance of the wood fibre between the electrodes is compared with known standards within the instrument. Specialized electrodes are provided for use where penetration of the surface must be avoided. Surprisingly enough, for an exhibit at an electronics exhibition, the circuit of the moisture-in-cereals meter is a development of the Wheatstone bridge and is independent of valve characteristics. It is, of course, also independent of voltage variations. The test cell applies great pressure to the specimen, thereby reducing it to a uniform state.

The *EM3* electron microscope was shown by the Metropolitan-Vickers Electrical Co., Ltd., which also showed the electrostatic clutch. Another exhibit was an electronic speed-control apparatus, in which the speed of an electric motor is controlled by electronic equipment using thyratrons actuated by a valveless magnetic amplifier. The motor is controlled against a constant torque throughout a wide speed range, the accuracy obtainable being 2 per cent of the maximum speed. Using thermionic amplifiers, the accuracy claimed is 0·1 per cent. A current-limit feature prevents overload.

The same firm has under development a radiation pyrometer for the recording and controlling of temperature. A thermocouple exposed to the heat radiated by the source is used to record the temperature, and the control is exerted by a photo-electric cell which is sensitive to infra-red radiation. The output from the cell actuates a Schmidt trigger circuit feeding a relay which is connected in series with the source supply. Since the thermocouple is not in contact with the source, there is no temperature limit.

Muirhead and Co., Ltd., showed an acoustic strain-gauge; this instrument, which measures strain in structures in terms of the change in frequency of a vibrating wire, is robust and portable. A valve-maintained tuning fork for use as a mains frequency stabilizer was also on view. The frequency is maintained constant to 50 parts in 1 million.

A new industrial viscometer and the ultrasonic generator were exhibited by Mullard Electronic Products, Ltd. The viscometer is for the continuous monitoring of viscosity and operates on the drag disk principle, employing an electronic method of torque measurement. The instrument measures from 0 to 10^6 centipoises in three ranges using three interchangeable heads. The ultrasonic generator is of the high-frequency piezo-electric type developing from 600 watts to 1 kilowatt. As a demonstration experiment a stable emulsion of mercury and water was produced.

The Plessey Co., Ltd., demonstrated its two-stage electromagnetic electron microscope. It also showed samples of a soft magnetic core material having a finely laminated structure; one grade has a maximum permeability of 1,000, whereas another grade, although not having such a high maximum permeability, has remarkable machining properties and high strength.

A new and interesting instrument suitable for many problems of industrial control and measurement was shown by F. C. Robinson and Partners, Ltd. It is the proximity meter by Fielden, and is unique in that it is possible to carry out the operation without physical contact with the specimen. The instrument may be applied to any problem which may be resolved into a minute change in electrical capacitance relative to earth, and can measure dimensions and distortions of an order not possible by mechanical means. On this stand was also shown a neat and attractively finished high-speed pen recorder. 'Teledeltos' paper is driven by a synchronous motor, and the frequency response of the instrument is uniform up to 60 c./s. The same firm represented the Baldwin Instrument Co., Ltd., which is now developing an X-ray method for the continuous gauging of sheet metal.

It has been possible to mention only a few of the many interesting exhibits, and lack of space precludes any attempt to make more than a passing reference, in conclusion, to the pleasing finish of the products and the attractive way in which they were displayed.

H. STEEPLE

OBJECTIVES IN THE EDUCATION OF COLONIAL PEOPLES

AN afternoon session on September 2 of Section L (Education) of the British Association during the meeting at Newcastle upon Tyne was devoted to a consideration of objectives in the education of Colonial peoples. The session was opened by a paper read by Mr. W. E. F. Ward, deputy educational adviser at the Colonial Office. Mr. Ward pointed out that most of the problems commonly met with in Colonial education—isolation, malnutrition, parasitic diseases and imperfect communications—are common to Colonies and Sovereign States. The core of the problem is to educate one race in an alien culture, in order that it may attain full world citizenship. So far as British territories are concerned, responsible self-government is an accepted aim of Colonial policy, and education must accordingly be planned with this in view.

Education for citizenship often presents greater problems than it does in Britain. In all Colonial territories there are indigenous political and social systems and cultures, often ill-fitted to compete with Western ideas; while in many territories there are the special problems of a plural society. Education must be recognized as an instrument of social change, and must make its contribution towards the solution of social and political problems.

It is important to use indigenous culture as a basis for education, since a pupil will be better fitted to appreciate Beethoven or Shakespeare if he approaches them with a knowledge of his own native music or poetry. Education must begin with matter familiar to the child, and must grow gradually towards the unfamiliar and alien culture. Efforts are being made to keep the schools in touch with tribal life in regions where this exists as the basis of society; much damage could be caused if education resulted in a cleavage between the traditional elements of society and the educated youth. The education of women, so important everywhere, is particularly important in countries where social change is going on and where the school is so badly in need of the co-operation of the parents.

Colonial governments are too poor to develop educational facilities as rapidly as they would wish. This being so, it is essential that a developing educational system should within its limitations be a

balanced system, with primary and secondary schools of all types, and with corresponding facilities for university and advanced technical education and professional training. The aim should be to produce citizens of all types—professional and business men, administrators, craftsmen and technicians of all kinds—so as to enable the territories to take control of their economic and political affairs. Where it is not possible to provide schools for all the children, mass education must be provided to supplement the work of the schools, to raise the general level and make possible more effective co-operation between school and home.

Mr. E. E. Esua, general secretary of the Nigerian Union of Teachers, after contrasting the British tradition with its care for indigenous culture with the French tradition, which aims almost solely at imparting French culture, defined the main objectives in Colonial education as an attack on ignorance, poverty, malnutrition and disease, and rural squalor.

There must be, he said, a campaign for mass literacy, both in the vernacular and in English, and adult education of all kinds must be developed among the newly literate. He agreed that it is important to give full weight to indigenous culture in education, though this imposes a heavy burden on the pupil. In language training, for example, it is difficult not to concentrate effort on English in the higher classes; but on the other hand, the vernacular will not develop if it ceases to be studied at that level. The schools must be multiplied, though this is not likely to be possible unless teachers' conditions of service are improved. Women's education is especially important, and the teaching of hygiene and nutrition, with physical education, would help to raise the standard of living. Education should aim at producing people who are not merely developed as individuals, but also are conscious of their duty to society; spiritual ideals are all-important. In this connexion, something could be done to keep the schools in touch with the traditional community life by developing the native administrations into local education authorities on the English model; local initiative and control, especially in a large territory, is essential if the education system is to be in touch with the country's needs. The problem of poverty must be tackled by vocational training and by industrialization.

Sir John Russell, president of the British Association, stressed the difficulty of planning education for pupils of a different race. He spoke of the importance of improving the arrangements for the well-being of our Colonial guests who came to Britain as students.

The discussion was focused mainly on two points, the lack in the Colonies of economic resources for development, and the means of bringing about closer social contacts between the Colonial peoples and the people of Britain. One speaker thought that rapid industrialization might be too dearly bought at the price of disintegration of the old social system. Others queried whether business firms in the Colonies paid enough in local taxation; in reply to which Mr. Ward suggested that the total sums paid in dividends to shareholders would probably make little difference to the budgets of Colonial governments. The fear was expressed that too much secondary-grammar school type of education might lead to 'black-coated' unemployment.

Other speakers asked if teachers' exchange machinery could be set up, or other arrangements made for bringing Colonial students and teachers into contact with students, teachers or schools in Britain.

Sir Fred Clarke pointed out the intractability of the economic problem revealed by the discussion. While it was agreed that educational development is essential for economic progress, the annual revenues are unable to provide the educational staff needed, and the more teachers' salaries are raised, the fewer teachers will be available. Grants towards capital expenditure are comparatively unimportant; recurrent expenses are the great difficulty.

GERMAN TIMBER INDUSTRY DURING 1939–45

A REPORT* has been prepared by the Department of Scientific and Industrial Research, Forest Products Laboratory, Princes Risborough, dealing with the German timber industry during the Second World War. It deals with composite wood manufacture, wood bending, pencil manufacture, wood structural research, logging, etc., machinery and equipment, green wood preservatives other than coal tar, coal tar creosote for wood preservation during the War, and chemistry of wood and wood products. Curiously enough, Germany appears to have lagged far behind the United States and Great Britain in the development of many of the above. For example, coal tar creosote was by far the most common wood preservative in Germany prior to 1940, accounting for more than 90 per cent of wood preservative needs; during the War, it was absolutely restricted, and German pressure-treating plants were operated with water-borne preservatives such as flunax, basilit, wolman salts and zinc chloride. Flunax, specially prepared for war conditions, replaced creosote for more than 66 per cent of preservatives used.

Perhaps one of the most striking examples of the attitude of the Germans towards the new developments in wood utilization is evidenced in the case of plywood and allied products, which they regarded as of secondary importance in their preparation for war, few developments taking place during 1937–41. Their view then changed, but the pressure of events and allied bombing prevented them recovering the ground they had lost in this respect. Neither in the plywood nor the block-wood industries was any new plant found at the end of the War. The veneer handling, almost entirely of beech, was poor. In the case of laminated wood, however, useful information about the German practice in forming laminated materials from their beech veneers was obtained.

Another interesting point deals with fabricated houses, of which two types were under development—a low-cost house of timber frame and sawdust–gypsum mortar, and one constructed entirely of beech veneers made into plywood, laminated wood and compressed wood. The plans of this latter differ little from similar types in Great Britain; but the use of compressed wood panels in the various parts of the house is a new development. It would be of interest to compare this latter house with the new types being developed in America, as discussed at the Third World Forestry Congress. For those interested, this report merits a careful study.

* B.I.O.S. Overall Report No. 3: The Timber Industry in Germany during the Period 1939–1945. Pp. 16. (London: H.M. Stationery Office, 1948.) 6d. net.

LETTERS TO THE EDITORS

The Editors do not hold themselves responsible for opinions expressed by their correspondents. No notice is taken of anonymous communications

Absorption Spectra, Molecular Weights and Visual Purple

WEALE[1] in his recent communication has tried to derive the molecular weight of rhodopsin (visual purple) by using Houston's equation. There are several comments we feel should be made.

This relationship (like more recent ones based on quantum mechanics) connects the molecular extinction coefficient (ε) with the half-width (in wave numbers) of an absorption band. Before the molecular weight can be calculated, the intensity of absorption expressed in terms of unit weight of solute and unit length of light path (for example, $E_1^{1\text{ per cent}}_{1\text{ cm.}}$ has to be known. The lack of adequate evidence of purity means that the result of Broda, Goodeve and Lythgoe[2] indicates a minimum value only for $E_1^{1\text{ per cent}}_{1\text{ cm.}}$ at 500 mμ. A comparison of Houston's equation with later formulations reveals a difference of about 100 per cent between the constant terms. Houston's equation can be rearranged and $\varepsilon_{max.}$ ($\log_{10} I_0/I = \varepsilon c l$, c in gm. mol./litre, l is light path in cm.) substituted for k_m, and the following equation obtained:

$$\varepsilon_{max.} = \frac{1}{2{\cdot}303} \cdot \frac{e}{m} \cdot \frac{e}{m_H} \cdot \frac{10^{-3}}{n} \cdot p \cdot \frac{\lambda_m^2}{\lambda' - \lambda_m} \qquad (1)$$

(where $e/m = 1{\cdot}76 \times 10^7$ E.M.U., $\frac{e}{m_H} = 9{\cdot}57 \times 10^3$ E.M.U., n is refractive index of solvent, p is number of electrons per molecule giving rise to an absorption band with $\lambda_{max.}$ at λ_m (cm.), λ' (cm.) is the wavelength on the long wave-length side of $\lambda_{max.}$ at which the absorption is half $\varepsilon_{max.}$).

If $1/\lambda_m$ is put equal to ν_m, and $1/\lambda' = \nu'$, and if ν_m^2 is put equal to $\nu_m \nu'$ (cf. Houston[3]) one obtains

$$\varepsilon_{max.} = \frac{1}{2{\cdot}303} \cdot \frac{e}{m} \cdot \frac{e}{m_H} \cdot \frac{10^{-3}}{n} \cdot p \cdot \frac{1}{\nu_m - \nu'} \qquad (2)$$

$$= 7{\cdot}32 \times 10^7 \cdot \frac{p}{n^2} \cdot \frac{1}{\nu_m - \nu'}.$$

This should be compared with

$$\varepsilon_{max.} = \frac{1}{2{\cdot}303} \cdot \frac{2e^2 N \times 10^{-3}}{cm(\nu_m - \nu')} \cdot f \text{ (cf. Maccoll[4])} \qquad (3)$$

(where e is electronic charge, N is Avogadro's number, c is speed of light, m is mass of an electron, $\nu_m = 1/\lambda_m$ and $\nu' = 1/\lambda'$). The quantity f is the oscillator strength and is defined as follows (Mulliken and Rieke[5]):

$$f = \frac{1}{2{\cdot}303} \frac{mc^2}{\pi e^2 N} \int \gamma \varepsilon d\nu = 4{\cdot}31 \times 10^{-9} \int \gamma \varepsilon d\nu, \qquad (4)$$

where γ is the unknown correction for solvent, which is believed to be nearly 1·0 for hexane and similar solvents. For a narrow band

$$(\nu_m - \nu') \cdot \varepsilon_{max.} = \frac{2}{\pi} \int \varepsilon d\nu \text{ (cf. Mulliken and Rieke[5])}. \qquad (5)$$

Using these results and the data given by Weale, we can calculate f for the 555 mμ band of reduced hæmoglobin. The molecular weight is 69,500, and as there are four hæms per molecule the carrier weight is 17,400. As $E_1^{1\text{ per cent}}_{1\text{ cm.}} = 8{\cdot}1$, the value of $\varepsilon_{max.}$ is $8{\cdot}1 \times \frac{17{,}400}{10} = 14{,}100$. The half-width $\nu_m - \nu' = 900$ cm.$^{-1}$, and if these values are substituted in (3), f is found to be 0·085, which is very far from 1·0. A similar calculation for the Soret band of reduced hæmoglobin (data from Heilmeyer[6]) gives $f = 0{\cdot}81$.

It is therefore evident that the apparent success in calculating the molecular weight of hæmoglobin is due to a coincidence.

Approximate values for f have been calculated for absorption curves obtained in this laboratory for vitamin A and some related compounds. As the absorption curves are not quite symmetrical when ν is plotted against ε, we have drawn a perpendicular through $\nu_{max.}$ and have measured the area below the absorption curve between the limits $\nu_{max.}$ and $\nu_{max.} - 6{,}000$ (cm.$^{-1}$). Twice this area represents the symmetrical curve. These results are shown in the accompanying table.

Bayliss[11], assuming that the π-electrons in *trans* conjugated poly-enes can be treated as a one-dimensional electron gas, arrives at the formula $f = 0{\cdot}134\ (2N + 1)$, where N is the number of conjugated double bonds. For vitamin A the theory leads to $f = 1{\cdot}47$ (obs., Bayliss 1·05) and for β-carotene $f = 3{\cdot}08$ (obs. 2·49–2·69). On this basis the approach of f to unity or to 2 (see table) merely reflects the number of conjugated double bonds, and to apply the argument to rhodopsin requires a knowledge of the structure of the chromophore.

From the best rhodopsin curve obtained in this laboratory $2\int_{\nu_{max.}-6{,}000}^{\nu_{max.}} \varepsilon d\nu = 3{\cdot}58 \times 10^3 \times \varepsilon_{max.}$, where

Spectroscopic data for vitamin A and some related compounds. (ν is in wave numbers (cm.$^{-1}$), ε is the decadic molecular extinction coefficient)

Compound	$\lambda_{max.}$ (mμ)	$\varepsilon_{max.}$	$2\int_{\nu_{max.}-6{,}000}^{\nu_{max.}} \varepsilon d\nu$	f Oscillator strength	Solvent	Remarks
Vitamin A alcohol	326	48,300	$2{\cdot}26 \times 10^8$	0·97	Cyclohexane	—
Vitamin A acetate	328	48,500	2·14 ,,	0·92	Cyclohexane	—
Vitamin A$_3$	351	41,500	2·30 ,,	0·99	Ethanol	—
Retinene$_1$	385	39,800	1·94 ,,	0·84	Ethanol	—
Retinene$_3$	386	41,200	2·09 ,,	0·90	Light petroleum	—
Retinene azine*	465	108,000	4·49 ,,	1·92	Ethanol	—
Retinene aniline[10]*	500	45,500	2·07 ,,	0·89	Aqueous ethanol acid	Assumed one molecule of retinene and one molecule of aniline
Retinene methylamine[10]*	360	80,000	3·78 ,,	1·62	Aqueous ethanol alkaline	Assumed two molecules of retinene and one molecule of amine
Retinene methylamine[10]*	435	96,000	4·28 ,,	1·84	Aqueous ethanol acid	,,

* Indicator yellow analogues, retinene plus excess amine.

$\varepsilon_{max.}$ is the unknown molecular extinction coefficient per chromophoric group. It follows, therefore, that $\varepsilon_{max.} = 65{,}000\,f$. If we accept the value for $E\,\frac{1\text{ per cent}}{1\text{ cm.}}$ ($= 6{\cdot}6$ at 500 mμ) as given by Broda *et al.*[2] as a minimum value, it follows that the maximum value of the carrier weight is $65{,}000\,f \times \frac{10}{6{\cdot}6} = 98{,}500\,f$.

If we also accept Hecht and Pickels's[7] experimental value of 270,000 for the molecular weight of rhodopsin, it follows that the number of chromophoric groups per molecule will be not greater than $\frac{270{,}000}{98{,}500\,f} = 2{\cdot}74/f = n$ (say). Hence $f \geqslant 2{\cdot}74/n$.

If $n = 1$, $f \geqslant 2{\cdot}74$; if $n = 2$, $f \geqslant 1{\cdot}37$; if $n = 3$, $f \geqslant 0{\cdot}91$; and if $n = 4$, $f \geqslant 0{\cdot}68$. If it is assumed that the preparation of Broda *et al.* was not far from pure, we can draw some further conclusions. It seems unlikely that f is greater than 2 (see table), and hence $n = 1$ is unlikely to be true; f is also unlikely to be less than the minimum value (0·84) shown in the table for the possible precursors of the rhodopsin chromophore, and therefore a value of $n = 4$ is not likely. The effect of the solvent has been ignored and this will add to the difficulty of deciding between $n = 2$ and $n = 3$.

It will be seen, therefore, that the question posed by Weale cannot yet be answered finally, even when data on strictly relevant compounds are considered in the light of current quantum mechanical approximations. Either rhodopsin must be obtained pure or the structure of the chromophore must be unequivocally established.

It is hoped to present elsewhere a fuller account of the structure of rhodopsin and of the most probable value for $\varepsilon_{max.}$

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[1] Weale, R., *Nature*, **163**, 916 (1949).
[2] Broda, E. E., Goodeve, C. F., and Lythgoe, R. J., *J. Physiol.*, **98**, 397 (1940).
[3] Houston, R. A., *Proc. Roy. Soc.*, A, **82**, 606 (1909).
[4] Maccoll, A., *Quart. Rev. Chem. Soc.*, **1**, 16 (1947).
[5] Mulliken, R. S., and Rieke, C. A., *Rep. Prog. Physics*, **8**, 231 (1941).
[6] Hellmeyer, L., "Spectrophotometry in Medicine" (Adam Hilger, Ltd., London, 1943).
[7] Hecht, S., and Pickels, E. G., *Proc. U.S. Nat. Acad. Sci.*, **24**, 172 (1938).
[8] Shantz, E. M., *Science*, **108**, 417 (1948).
[9] Ball, S., Goodwin, T. W., and Morton, R. A., *Biochem. J.*, **42**, 516 (1948).
[10] Ball, S., Collins, F. D., Dalvi, P. D., and Morton, R. A., *Biochem. J.*, (in the press).
[11] Baylis, N. S., *J. Chem. Phys.*, **16**, 287 (1948).

Species Differences in Insulins

From a study of a number of crystalline insulins from different animal species, Scott and Fisher[1] found that they all had the same microscopic appearance, sulphur content and physiological activity; and Wasserman and Mirsky[2] could find no immunological differences using sensitization and complement fixation experiments. It has thus often been concluded that different insulins are chemically identical, although almost all other proteins have been found to show species differences. The following experiment shows, however, that there are certain definite differences in the detailed chemical structure of insulins from different animal species.

Source of insulin	Serine	Glycine	Threonine	Alanine
Ox	++	+	—	++
Pig	++	+	+	+
Sheep	+	++	—	++

Samples of insulins derived from the ox, pig and sheep were oxidized with performic acid and the *A* fractions prepared[3]. There were no differences in the course of fractionation and separation into the two main fractions, *A* and *B*, indicating the same general overall structure. The *A* fractions were hydrolysed and the amino-acids identified and estimated semi-quantitatively by paper chromatography. There were considerable differences in the contents of the amino-acids, serine, glycine, threonine and alanine, but not of the other amino-acids. The most significant of these differences, which are summarized in the accompanying table, is the presence of threonine in the fraction *A* of pig insulin and its absence from the others.

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[1] Scott, D. A., and Fisher, A. M., *Trans. Roy. Soc. Canada*, **34**, (V), 137 (1940).
[2] Wasserman, P., and Mirsky, I. A., *Endocrin.*, **31**, 115 (1942).
[3] Sanger, F., *Biochem. J.*, **44**, 126 (1949).

Primary Site of the Action of Cobalt in Ruminants

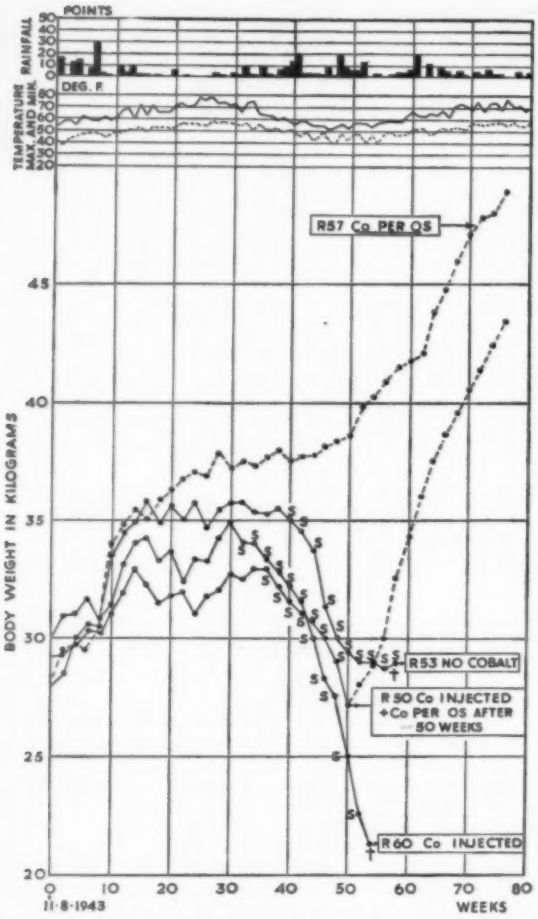
In the course of the first (1935–36) series of experimental investigations of the etiology of the fatal malady, coast disease, which affects sheep confined to the pastures of the calcareous littoral of southern Australia, we observed the dramatic improvement which supervened when sheep that were suffering acute symptoms were dosed with cobalt[1].

In general, the cobalt content of the tissues of the sheep which succumbed to the malady was considerably reduced; in some cases, however, the cobalt present in the liver and in other organs was of the same order of concentration as that found in healthy sheep grazed where deficiencies of this nature never appear. As the animals employed for these experiments were bred on normal pastures, it seemed probable that the cobalt which had accumulated in their tissues prior to their transfer to the deficient terrain exerted little, if any, influence on the progress of the symptoms which appeared afterwards.

Later, we established depots of cobalt in experimental sheep by introducing relatively massive doses of sparingly soluble cobalt subcutaneously, and observed no benefit from this procedure; although at any stage of the syndrome these sheep would respond immediately to very small quantities (0·1 mgm./day) of cobalt *per os*. On investigating the reason for this we obtained, in 1943–44, evidence which suggested that cobalt must be *ingested* if it is to be effective; when injected into the blood stream it exerted no beneficial effect, although the concentration of cobalt in the blood-stream and in the organs was by this means increased at least ten-fold.

The details of these experiments have not as yet been published. The results were reported to a meeting of the Nutrition Society[2] by Sir Charles Martin, and later referred to in a review by McCance and Widdowson[3].

The observations set out in the accompanying graph and explained in the legend are typical of this first



The individuals of the group of four merino ewes (aet. approx. nine months at beginning of experiment) were grazed together on cobalt-deficient pastures and treated as follows: *R*.57 with the equivalent of 1 mgm. cobalt a day administered once a week *per os*; *R*.60 and *R*.50 with 1 mgm. cobalt a day injected once a week into the jugular vein; *R*.53 was untreated. After 50 weeks, when the deficiency symptoms were in a terminal stage, *R*.50 received the equivalent of 1 mgm. cobalt a day *per os* in addition to that injected. *S* denotes recognizable deficiency symptoms. The behaviour illustrated above was typical of that of the animals in other groups

experiment. We have since extended these observations using sufficiently large groups of animals to allow statistical assessment of any *small* benefit which might accrue from injected cobalt. These observations are now complete, and the results show unequivocally that cobalt introduced parenterally is of no benefit to sheep depastured on cobalt-deficient pastures.

Cobalt thus exerts its influence on the ruminant primarily either in the lumen of the alimentary canal or when passing through its wall. The site of this activity is apparently above the level of the duodenum; cobalt introduced intravenously is in part voided in the fæces and appears in the intestinal tract below this level.

It is probable, then, that an important function of cobalt in the ruminant may concern the activity of the symbiotic flora within the paunch.

The fact that sheep and cattle are apparently the only animals which suffer the consequences of cobalt deficiency while grazing on deficient terrain—marsupials abound on these areas, rabbits if unchecked will assume plague proportions, and horses do exceptionally well there—implies that the ruminant is unique in its higher demand for this element.

The experimental findings will be published elsewhere, together with the results of experiments which indicate that neither the anæmia, nor the other symptoms of extreme cobalt deficiency, responds to Minot's antipernicious anæmia factor introduced parenterally either as concentrated liver extracts or as crystalline vitamin B_{12} in quantities which would rapidly correct the dyscrasia of human pernicious anæmia. From the evidence that is now well established, it appears that we may seek with confidence a less restricted physiological role for cobalt than the part it takes in the bone marrow during the maturation of the erythrocytes.

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[1] Lines, *J. Coun. Sci. Ind. Res., Aust.*, **8**, 117 (1935). Marston, *ibid.*, **8**, 111 (1935).; *Bull. Coun. Sci. Ind. Res., Aust.*, **113**, 9, 14 (1938); *Nature*, **141**, 398 (1938); *Ann. Rev. Biochem.*, **8**, 557 (1939). Marston and McDonald, *Bull. Coun. Sci. Ind. Res., Aust.*, **113**, 72, 79 (1938). Marston, Lee and McDonald, *J. Agric. Sci.*, **38**, 216, 222 (1948).
[2] Martin, *Proc. Nutr. Soc.*, **1**, 195 (1944).
[3] McCance and Widdowson, *Ann. Rev. Biochem.*, **8**, 315 (1944).

Toxicity of Polar Bear Liver

ACCORDING to information from the Eskimos, and records from Arctic travellers, bad effects may follow the consumption, by men and dogs, of the livers of polar bear, bearded seal, Greenland fox and Eskimo huskies, whereas livers of other Arctic mammals can usually be eaten without injury.

Rodahl and Moore[1] found specimens of livers of polar bear and bearded seal to be very rich in vitamin A, and, as a result of preliminary biological tests on rats, concluded that the toxic effect of bear and seal liver might depend on the very high content of vitamin A in these livers, resulting in the condition of hypervitaminosis A. Attempts to fractionate the liver into toxic and non-toxic constituents were unsuccessful, however.

I have investigated the toxic effect of polar bear liver on experimental animals. Two specimens of bear liver brought back from north-east Greenland in 1947 contained 26,700 and 21,900 I.U. vitamin A./gm. respectively of wet material.

In experiments on rats, ingestion of 0·5–0·6 gm. polar bear liver daily proved toxic in all cases. In two cases 0·5–0·7 gm. polar bear liver daily proved lethal.

Various fractions of the polar bear liver were given to different groups of rats with the following results. Polar bear liver freed of its vitamin A was non-toxic. Bear liver, bear liver oil containing all its vitamin A, and purified vitamin A concentrates, had identical effects when given in equivalent amounts with regard to the vitamin A content. Equivalent amounts of bear liver oil in which the vitamin A had been destroyed had no bad effects. The symptoms increased with increasing amounts of vitamin A. The possibility of hypervitaminosis D was excluded, as

the bear liver had only a very slight antirachitic effect.

It is therefore confirmed that the toxic substance in polar bear liver is identical with vitamin A, and that ingestion of large quantities of polar bear liver leads to hypervitaminosis A.

Livers of snow hare and walrus, which are considered non-poisonous by the Eskimos, contained very small amounts of vitamin A, whereas the liver of Greenland fox, known to be poisonous, contained 12,000 I.U. vitamin A./gm. liver.

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[1] Rodahl, K., and Moore, T., *Biochem. J.*, **37**, 166 (1943).

Hypervitaminosis A and Scurvy

THE similarity between the clinical picture of hypervitaminosis A in rats and that of scurvy has been pointed out by Vedder and Rosenberg[1], who found that ascorbic acid offered protection against excess of vitamin A; and also by Moore and Wang[2], who failed, however, to detect any abnormality in the ascorbic acid metabolism in their hypervitaminotic rats.

As an extension of previous investigations[3,4], the condition of hypervitaminosis A has been subject to detailed studies in rats, mice, guinea pigs, rabbits, dogs and chicken. Within a few hours after single doses in the range 50–100 I.U. vitamin A./gm. body-weight, symptoms of acute intoxication occurred in the form of general malady, changes in the pelts, drowsiness, muscular weakness and decreased activity. Continued administration of the same dose during a longer period caused symptoms of chronic intoxication. A number of these clinical symptoms as well as post-mortem findings were identical with those observed in human scurvy, such as muscular weakness, pains in limbs, scattered small hæmorrhages apparently due to abnormal capillary permeability, hæmaturia, intestinal bleeding with diarrhœa, subperiostal hæmatomata, epistaxis, blood extravasations into the muscles, susceptibility to infection, inconstant hypochrome anæmia, hepatic and renal damage, widening of the costochondral junction, characteristic X-ray findings, and changes in the teeth such as hyperæmia, hæmorrhages, vacuoles and deposits of calcium in the pulp, as well as degeneration and disarrangement of the odontoblasts and amorphous calcification of the inner part of the dentine. Even the microscopical picture of the long bones may to some extent resemble that of scurvy. In the majority of cases, abnormally low ascorbic acid contents were found in the serum, adrenals and liver.

The clinical picture and the post-mortem findings in guinea pigs given excess of vitamin A, and in those given a scorbutic diet, were very similar. Thus in both cases there was absence of normal gain in weight, hyperæmia and hæmorrhages—particularly muscular hæmorrhages in the hind legs, as well as bleeding in the knee joints. The bone abnormalities were similar, as judged by rœntgenograms and microscopical examination, and in both cases the bones were brittle. The ash and mineral content of the bones was practically identical. Similar findings were revealed in the kidneys by microscopical examination, such as scattered red blood cells outside the capillaries and in the space of Bowman's capsule, and slight degeneration of the renal tubules. Finally, the same low content of ascorbic acid in the liver and in the serum was detected in both cases. Furthermore, similar gross doses of vitamin A proved more toxic to guinea pigs given a scorbutic diet than in those given the usual adequate basal diet.

In a dog given 380 I.U. vitamin A./gm. body-weight daily during a period of 57 days, bleeding from the gums and swelling of the gingiva were also observed in addition to the symptoms already described for the rats. The ascorbic acid content of the blood was 0·7 mgm./per 100 ml. at the commencement of the experiment, and 0·0 mgm. at the end of 57 days.

It is thus evident that prolonged administration of excess of vitamin A in experimental animals produces a condition which resembles scurvy, although abnormality in the vitamin C metabolism cannot in any way be considered as the sole causative factor in hypervitaminosis A.

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[1] Vedder, E. B., and Rosenberg, C., *J. Nutrit.*, **16**, 57 (1938).
[2] Moore, T., and Wang, Y. L., *Biochem. J.*, **39**, 222 (1945).
[3] Rodahl, K., and Moore, T., *Biochem. J.*, **37**, 166 (1943).
[4] Rodahl, K., *Nature*, see preceding communication.

Ascorbic Acid Content of Some Local Barbados Foods

THE West Indian diet normally contains a high proportion of starchy 'roots' and fruits such as yams, sweet potatoes, eddoes, breadfruit, banana, etc., but very few leafy green and yellow vegetables, and in some islands very little fruit. This means that, for many people, almost the only source of dietary ascorbic acid is that contained in these starchy roots and fruits. These foods do not contain a very high proportion of ascorbic acids; but, if very large quantities of them are eaten, even these small amounts will be of major dietary importance. It is by no means unusual for a West Indian diet to contain 1¼ lb. or more of starchy vegetables, which would contain an appreciable quantity of ascorbic acid: for example, 100 gm. sweet potato contains 20 mgm. ascorbic acid and 500 gm. (1¼ lb. approx.) contains 100 mgm. ascorbic acid, which quantity is well in excess of the average daily requirement. (Figures taken from Revised Dietary Requirements recommended by National Research Council.) No allowance has been made for possible losses in vegetables during cooking.

According to the "Tables of the Representative Values of Foods commonly used in Tropical Countries"[1], most of the starchy roots and fruits contain some ascorbic acid, with the exception of yams and eddoes. As these two foods figure so largely in the West Indian diet, it was decided to carry out a chemical assay of L-ascorbic acid (vitamin C) on some locally grown varieties. This investigation was later extended to include a number of local fruits and tinned fruit juices not listed in the above food tables, to discover whether they contained any significant quantities of ascorbic acid.

The chemical method followed was volumetric titration of vitamin C extract with 2 : 6-dichlorophenol-indophenol dye, as set down in A.O.A.C. methods[2]. Sampling of the roots was carried out by coring them with a cork borer (size No. 9); the

number of roots taken depending on their size; for example, eddoes, 10–12 corms, yams, 2 tubers. The fruits were peeled except in the case of the gooseberries (*Phyllanthus distichus*) and dunks (*Zizyphus jujuba*) as the skin is usually eaten, but before coring the stones were removed from the flesh. In the case of tinned fruit juices, 10 ml. of the juice was pipetted from tins of random selection. In all cases, approximately 10–15 gm. of each sample was then weighed out and extracted with 100 ml. of the extracting solution. This was filtered before aliquots were taken for titration, which was triplicated each time. (A blank consisting of a similar volume of solutions, with distilled water in place of the extract, was also included with each triplicated set of titrations.)

Products	Notes	Ascorbic acid content
ROOTS:		
Yam (large Lisbon) (mature) (*Dioscorea alata*)	Sample ½ in. into root, skin left on	6·1 mgm./100 gm.
Yam (large Lisbon) (mature)	Sample inside yam (after peeling)	6·5 ,, ,,
Yam (long Lisbon × Horn) (mature)	Sample inside yam (after peeling)	7·0 ,, ,,
Eddoe (white) (mature) (*Colocasia antiquorum*)	Sample inside eddoe (after peeling)	3·7 ,, ,,
Eddoe (nut) (mature) (*Colocasia esculenta*)	Sample inside eddoe (after peeling)	2·8 ,, ,,
TINNED FRUIT JUICES:		
Trinidad orange and grapefruit juice	(+ 5 per cent sugar)	23·4 mgm./100 ml.
Trinidad grapefruit juice	(+ 5 per cent sugar)	(*a*) 24·1 mgm./100 ml. (*b*) 28·3 ,, ,,
Jamaican orange juice	(+ 5 per cent sugar)	(*a*) 30·9 ,, ,, (*b*) 32·9 ,, ,,
FRUITS:		
Barbados gooseberry (*Phyllanthus distichus*)	Mature sample (yellow)	*3·7 mgm./100 gm.
Dunks (*Zizyphus jujuba*)	Mature sample	4·3 ,, ,,
Dunks (*Zizyphus jujuba*)	Old sample, going soft	0·3 ,, ,, (negligible quantity)
Sour sop (*Annona muricata*)	Mature sample	12·4 mgm./100 gm.
Mammy apple (*Mammea americana*)	Mature sample	4·3 ,, ,,
Sapodillas (*Achras zapota*)	Mature sample	0·8 ,, ,, (negligible amount)

* Variation in ascorbic acid content with maturity, when green and unripe, content much lower.

It was found that both yams and eddoes contained less ascorbic acid than the other starchy roots and fruits, but if they were eaten in any large quantity the ascorbic acid contribution to the diet would be significant: for example, 500 gm. yam at 6·1 mgm./100 gm. = 30·5 mgm. ascorbic acid, which represents almost half the daily requirement.

The values found for local fruits were low, with perhaps the exception of sour sop (*Annona muricata*), and it is unlikely that any of them would be eaten in sufficient quantity to make an important contribution to the diet.

The tinned fruit juices, however, contain high quantities of ascorbic acid: for example, a 6-oz. glass of grapefruit juice = 45 mgm. ascorbic acid, which would be sufficient for the average daily requirement, as no allowances would have to be made for further losses during cooking.

It might have been expected that the extracting, processing and tinning of these fruit juices would have led to the destruction of the greater proportion of the ascorbic acid content; but such does not seem to have been the case.

Two fruits which are common in Barbados are the guava and Barbados cherry. The former has been investigated by numerous workers and found to contain large quantities of ascorbic acid. Some work published on the latter[3] has shown that there is a very high content of ascorbic acid in this fruit, too. Unfortunately, we were unable to obtain any of this material when our work was being carried out.

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[1] Platt, Medical Research Council, Special Report, Series No. 253 (London: H.M. Stationery Office, 1945).
[2] A.O.A.C. Methods of Analysis (1945).
[3] Asenjo and Frieire de Guzman, *Science*, **103**, 219 (1946). Mustard, Margaret J., *Science*, **104**, 230 (1946).

Ultra-Violet Absorption of Living Cells

ULTRA-VIOLET light has been used in microscopy mainly because it makes possible the study of the distribution in cells of absorbing substances, such as nucleic acids, proteins and organic iodine compounds. There has, however, been controversy about the ultra-violet absorption of living cells since Brumberg and Larionow[1] questioned the findings of earlier workers[2] and suggested that living cells have only a very low absorption around 2600 A., which increases markedly after a few minutes irradiation. The elegant photographs of Ludford, Smiles and Welch[3], on the other hand, indicate that fresh cells of the *Rb* tumour show marked nuclear and cytoplasmic absorption when first observed at 2570 A. and 2750 A.

The observations described here have been obtained using a high-pressure mercury discharge lamp, quartz optics and photomultiplier tubes for absorption measurements on areas down to 1 μ in diameter, in a manner similar to that described by Gersh and Baker[4]. As interest was centred on absorption changes, no attempt was made to compute extinction coefficients, or to deduce the concentration of absorbing substances. It has not, as yet, been possible to measure the incident light intensity, but during the observations described below it has been kept constant to within 10 per cent at any one wave-length. All cells were freshly mounted in the appropriate Ringer solution and showed distinct absorption at 2536 A., 2650 A. and 2800 A., both after the fraction of a second which elapses between switching on the ultra-violet light and first perceiving the image in the fluorescent eyepiece, the microscope having been prefocused for the ultra-violet[5], and after the 10 sec. irradiation required for photography or absorption measurements.

Species of *Paramecium*, *Spirostomum* and *Rhabditis* showed both nuclear and cytoplasmic absorption from the moment they swam into the ultra-violet beam. As irradiation continued, however, different cells behaved in all three possible ways, the absorption increasing in some, decreasing in others and showing little change in a third group. (1) The cytoplasmic absorption of erythrocytes of frog, fowl and mouse showed a slight initial decrease, but then increased markedly and reached twice its initial value after five minutes irradiation (Fig. 1). This appears to be due to cell shrinkage. Increased absorption in the nuclei of frog and fowl erythrocytes may be due largely to the increasing density of the surround-

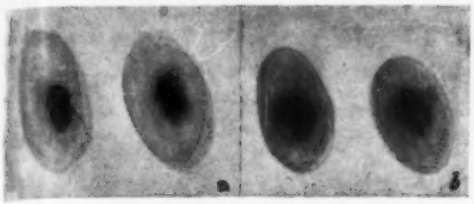

Fig. 1. Two frog erythrocytes photographed at 2650 A.: (*a*) after 20 seconds irradiation (including the photography), and (*b*) after five minutes irradiation (at 2650 A.)

ing cytoplasm. Chick fibroblasts showed smaller increases and had very low initial absorption, though the work of Davidson and Waymouth[6] indicates that this varies with the condition of the culture. (2) In smears of loose cell sarcomata (*OA* and Earle *HGW*) the strong nuclear and cytoplasmic absorptions showed little change as irradiation at 2650 A. continued. (3) Myeloblasts, erythroblasts and other stem cells in bone marrow (not specifically identified), as well as lymphocytes and thymocytes (all mouse), showed a fall in nuclear absorption of about 15 per cent, when irradiated and measured at 2650 A. (Fig. 2). Space does not permit description of changes at other wave-lengths, but it is of interest to note that the fall is prevented by the presence in the Ringer solution of various compounds (kindly given by Dr. E. S. G. Barron) which have in common the property of inactivating sulphydryl groups (Fig. 2). Mercuric chloride (0·0002 *M*) acts similarly, but cysteine and azide (both 0·001 *M*) are without effect.

The fall in nuclear absorption in the cells of group (3) may be due to several causes, among which are the following: (*a*) swelling of the nucleus; (*b*) a change in state of nuclear material; (*c*) partial depolymerization and loss of nucleoprotein; (*d*) changes in membrane permeability facilitating the loss of nuclear material. No evidence of swelling can be obtained from a limited number of photographs of the cells taken with visible light before and after ultra-violet irradiation. It is at present impossible to decide between the other possibilities. Since, however, cutting off the light arrests the fall in absorption, it is unlikely that permeability changes of type (*d*) are the sole cause. There is, moreover, evidence that changes of type (*c*) can occur in other systems. Solutions of desoxyribonucleic acid are depolymerized by ultra-violet irradiation[7], which also accelerates the escape from yeast cells of compounds which are very probably the breakdown products of nucleic acids[8]. The fact that sulphydryl inactivators prevent the fall in nuclear absorption in irradiated cells raises the possibility that the state of the sulphydryl groups influences the behaviour of nucleoproteins in the cell. The work of Rapkine[9] and others has revealed the abundance of sulphydryl groups in the cell just before and during the prophase of mitosis, when extensive changes in nucleic acid distribution are taking place; but the sulphydryl content of the nucleus of *Amœba* falls sharply at metaphase[10], when the nucleic acid is, presumably, most firmly bound to the chromosomes. In various eggs, regions of cytoplasm rich in nucleotides are also rich in sulphydryl groups[9]. From a rather different aspect, Henry and Stacey[11] have demonstrated that after removal of the Gram-positive material from bacteria, the magnesium ribonucleate which appears to be responsible for the staining can only be recombined with the cytoskeleton if the latter is in a reduced state, which involves, among other things, the presence of free sulphydryl groups. Such previous observations and those described here are in accordance with the view that, under certain conditions, the breakdown and formation of nucleoproteins depend on the presence of some free sulphydryl groups, and that absence of the latter inhibits these processes.

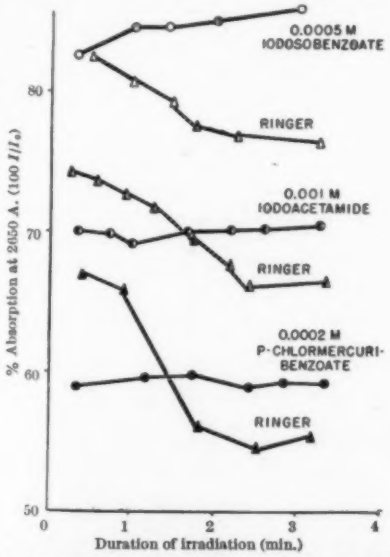

Fig. 2. The change in nuclear absorption at 2650 A. of stem cells of bone marrow during irradiation at 2650 A. under various conditions. Each pair of curves represents cells from one mouse. (The above were selected from many similar curves because they could all be shown on one graph)

Any such hypothesis must, however, be distinguished from the experimental facts, which are as follows. The living cells examined absorbed ultra-violet radiation around 2600 A. as soon as they could be observed; but continued irradiation of the intensity required for measurement caused changes in several cases. The fall in absorption produced in some cells was arrested by switching off the light and was prevented, even during continuous irradiation, by the presence of sulphydryl inactivators.

We are much indebted to Dr. I. Gersh and Mr. F. Vaughn for advice and assistance, and to the American Cancer Society, the Commonwealth Fund and the U.S. Public Health Organisation for support.

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[1] Brumberg, E. M., and Larionow, L. T., *Nature*, **158**, 663 (1947).
[2] Wyckoff, R. G. W., Ebeling, A. H., and Ter Louw, A. L., *J. Morph.*, **53**, 189 (1932). Caspersson, T., *Symp. Soc. Exp. Biol.*, **1**, 127 (1947).
[3] Ludford, R. J., Smiles, J., and Welch, F. V., *Nature*, **162**, 650 (1948).
[4] Gersh, I., and Baker, R. F., *J. Cell. Comp. Physiol.*, **21**, 213 (1943).
[5] Mitchell, J. S., *Brit. J. Exp. Path.*, **23**, 285 (1942).
[6] Davidson, J. N., *Cold Spring Harbor Symp.*, **12**, 51 (1947).
[7] Hollaender, A., Greenstein, J. P., and Jenrette, W. V., *J. Nat. Canc. Inst.*, **2**, 23 (1941).
[8] Loofbourow, J. R., Cook, E. S., and Stimson, M. M., *Nature*, **142**, 573 (1938). Hevesy, G., and Zerahn, K., *Acta Radiol.*, **27**, 316 (1946).
[9] Brachet, J., "Embryologie Chimique" (2nd edit., 1945).
[10] Chalkley, H. W., *Protoplasma*, **28**, 489 (1937).
[11] Henry, H., and Stacey, M., *Proc. Roy. Soc.*, B, **133**, 391 (1946).

Alternaric Acid, a Biologically Active Metabolic Product of the Fungus *Alternaria solani*

SEVERAL strains of *Alternaria solani* (E. and M.) Jones and Grout and one of *A. porri* (Ell.) Saw. have been found to produce in liquid media a substance which causes a characteristic 'stunting' effect on developing germ tubes of *Botrytis allii*, in our standard germination test[1], without reducing percentage germination. We have also found that germination of spores of other fungi, notably those of *Myrothecium verrucaria*, is inhibited, so that a more satisfactory assay can be developed. Greatest activity develops in cultures on Czapek–Dox medium containing 10–15 per cent sucrose; sucrose is appreciably superior to glucose or other sugars. From such culture filtrates, using a strain of *Alternaria solani* (No. 408 in our collection), we have isolated a material, for which we propose the name 'alternaric acid', which appears to be responsible for both the antifungal effects mentioned above.

Alternaric acid is obtained by adjusting the culture filtrate to *p*H 3·5 and extracting with chloroform; the gummy residue left after evaporation of the chloroform is dissolved in hot carbon tetrachloride or benzene, and crystalline alternaric acid appears on cooling. Yields of the crude crystalline material of the order of 100 mgm./l. are obtained. Further crystallization from benzene may be necessary to remove a bright orange impurity, and the colourless material can then be purified by repeated crystallization from ethanol or water. It is an optically inactive dibasic acid, m.p. 134° C.; the chemistry of alternaric acid will be reported elsewhere.

Alternaric acid is not appreciably antibacterial. Its antifungal activity is remarkably specific. Germination of spores of *Absidia glauca*, *Myrothecium verrucaria* and *Stachybotrys atra* is inhibited in the range 0·1–1·0 μgm./ml. On the other hand, percentage germination of spores of *Botrytis allii*, *Fusarium cæruleum* and *Penicillium digitatum* is unaffected by concentrations as high as 200 μgm./ml., but a reduction in the rate of hyphal extension, leading to the production of 'stunted' forms, is caused by much lower concentrations. A clearly visible 'stunting' effect on *B. allii* germ tubes is produced by 0·01 μgm./ml. alternaric acid. This type of antifungal activity, in which high specificity is combined with this 'stunting effect', in our experience has only been shown by alternaric acid and by mycophenolic acid. The antifungal specificity of mycophenolic acid has been noted by Gilliver[2].

Alternaria solani is normally parasitic on plants of the family Solanaceæ, but according to Neergaard[3] may also infect plants in other families, such as Cruciferæ and Compositæ. Whipple[4] and Thomas[5] have suggested that *A. solani* produces a diffusible toxin in host (tomato) tissues which causes wilting and collapse of tissues in advance of the actual infection. It is of interest to consider whether alternaric acid may be responsible for this phytotoxic effect. We have introduced alternaric acid into nutrient solutions in which tomato, pea, beet, radish, cabbage, mustard and carrot seedlings were growing; concentrations of 5–10 μgm./ml. caused, after an interval of seven to ten days, a severe wilt followed by death of the radish, cabbage, mustard and carrot seedlings; but the other seedlings were apparently unaffected. Seeds of radish, mustard, tomato, clover and wheat were incubated on agar containing alternaric acid; growth of the radish, mustard and tomato seedlings was severely retarded by 1–5 ugm./ml. alternaric acid; but wheat and clover were somewhat more resistant. Thus, alternaric acid is undoubtedly phytotoxic, but its significance in the etiology of parasitic attack by *A. solani* needs further investigation.

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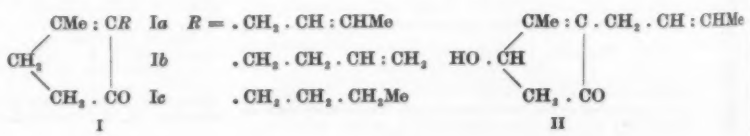
[1] Brian and Hemming, *Ann. App. Biol.*, **32**, 214 (1945).
[2] Gilliver, *Ann. Bot.*, **10**, 271 (1946).
[3] Neergaard, "Danish Species of Alternaria and Stemphylium" (Copenhagen, 1945).
[4] Whipple, Wisconsin Univ. Sums. Doct. Diss., **3**, 65 (1938).
[5] Thomas, *J. Agric. Res.*, **76**, 289 (1948).

Synthesis of Cinerone, Cinerolone and of Cinerin-I

As part of a scheme to elucidate by synthetical methods the structures of the cinerins and pyrethrins, the important insecticidal constituents of pyrethrum flowers, one of us in 1946[1] synthesized 2-but-2′-enyl- and 2-but-3′-enyl-3-methyl*cyclo*pent-2-enone (I*a* and I*b*) for comparison with cinerone, which is a degradation product of cinerolone[2]. LaForge and Barthel[2] had previously shown that dihydrocinerone was identical with 3-methyl-2-*n*-butyl*cyclo*pent-2-enone (Ic), so that only the position and configuration of the side-chain double bond was in question. They had assigned this to the 2′ position on the somewhat uncertain basis of terminal methyl values[2]. This assignment accords with the ultra-violet absorption spectrum of (+)-cinerolone, which excludes the 1′ position; and the non-identity of cinerone with synthetic I*b*, which excludes the 3′ position[1]. We have confirmed the but-2′-enyl side-chain in (+)-cinerolone by ozonization, using a specimen prepared from the semicarbazone (kindly provided by Dr. T. F. West). This yielded acetaldehyde together with a small proportion of formaldehyde. The latter product indicates a small proportion of contaminant, probably pyrethrolone.

The synthetic substance I*a* was not identical with cinerone, although showing fairly close resemblance (see the accompanying table), for both the semicarbazones and *p*-nitrophenylhydrazones gave depressions of melting point. It was concluded that cinerone had the opposite geometrical configuration of the side-chain double bond to the synthetic ketone[1]. The synthesis had started from crotonaldehyde, which Gredy and Piaux[4] have shown by Raman spectroscopy to possess the *trans* configuration. Consideration of the subsequent steps leads



		Synthetic Ib	Synthetic Ia (*trans*)	Synthetic Ia (*cis*)	Cinerone
Ketone	b.p. n_D	110°/13 mm. 1·4948 (25°)	119°/15 mm. 1·4983 (25°)	119°/15 mm. 1·4982 (25°)	— 1·4978 (31°)[3]
Semicarbazone	m.p.	188°	220° decomp.	212–214° decomp.	213–214° decomp.
p-Nitrophenylhydrazone	m.p.	127°	162°	151·5–152·5°	148–150°
2:4-Dinitrophenylhydrazone	m.p.	146°	161°	137–138°	—

us to conclude that this configuration was maintained throughout the synthesis, and that the final product possessed a *trans*-but-2′-enyl side-chain. We have confirmed this by another synthesis utilizing *trans*-pent-3-enol. By exclusion, therefore, cinerone and cinerolone have a *cis*-but-2′-enyl side-chain.

We have now prepared pent-3-ynol and converted it, by semi-hydrogenation over palladium on calcium carbonate, to almost pure *cis*-pent-3-enol. Conversion of this to the bromide and carbonation of the derived Grignard gave *cis*-hex-4-enoic acid. The latter was converted to 2-*cis*-but-2′-enyl-3-methyl-*cyclo*pent-2-enone (Ia) by the five-stage synthesis employed earlier, regenerating the pure ketone from its semicarbazone. The melting points of the derivatives of this ketone (see the table) suggested identity with cinerone, and this was confirmed by the absence of depressions on carrying out mixed melting points with the semicarbazones and *p*-nitrophenylhydrazones. Cinerone is therefore 2-*cis*-but-2′-enyl-3-methyl*cyclo*pent-2-enone and cinerolone is (II).

By condensing the appropriate intermediate with pyruvaldehyde[5], the way is now open to the synthesis of (±)-*cis*-cinerolone, and thence by esterifying with synthetic (±)-*trans*-chrysanthemic acid[6] to racemic cinerin-I; this is being exploited.

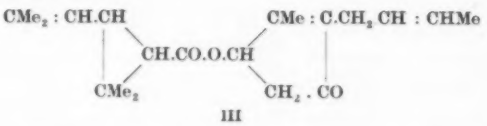
June 24.

As forecast in the preceding communication, we have now succeeded in synthesizing natural racemic cinerolone and thence of cinerin-I. The sodium salt, obtained by hydrolysis with 3 per cent sodium hydroxide at 20° of methyl *cis*-hept-5-en-2-one-1-carboxylate, an intermediate in the previous synthesis, was condensed with pyruvaldehyde in aqueous solution at 35° and *p*H 8·5 to give *cis*-dec-8-en-3-ol-2:5-dione. This hydroxydiketone was cyclized by 2 per cent sodium hydroxide at 20° to (±)-*cis*-cinerolone (II). The semicarbazones of this hydroxyketone and of its acetate (see the table) were shown by mixed melting point determinations to be identical with naturally derived racemic cinerolone and cinerolone (strictly cineronyl) acetate semicarbazones respectively. Specimens of the corresponding (±)-*trans*-cinerolone derivatives (prepared in collaboration with A. J. B. Edgar) markedly depressed the melting points of both the natural and synthetic (±)-*cis*-cinerolone derivatives.

Esterification of this synthetic (±)-*cis*-cinerolone with (+)-*trans*-chrysanthemyl chloride has enabled us to achieve a total synthesis of cinerin-I (III), for the synthesis and resolution of (±)-*trans*-chrysanthemic acid have already been described[6]. This synthetic cinerin-I has b.p. ~ 130–132°/4·5 × 10^{-3} mm., n_D^{20} 1·5043, and consists of the diastereoisomeric pair of esters, (+)-*cis*-cineronyl (+)-*trans*-chrysanthemate and (−)-*cis*-cineronyl (+)-*trans*-chrysanthemate (for an explanation of this nomenclature see ref. 7).

	Synthetic II (±)-*trans*	Synthetic II (±)-*cis*	Natural racemic cinerolone*
Hydroxyketone	n_D^{20} 1·5140	1·5135	1·5156
Semicarbazone	m.p. 209° decomp.	199° decomp.	198° decomp.
Acetate semicarbazone	m.p. 159°	148°	149°

* Prepared by regeneration from a specimen of the semicarbazone kindly supplied by Dr. T. F. West.



III

Furthermore, since both natural (+)-*cis*- and (±)-*cis*-cinerolone have previously been converted to cinerin-II, using natural chrysanthemum dicarboxylic acid monomethyl ester [(+)-*trans*-pyrethric acid][8], this work also constitutes a partial synthesis of cinerin-II.

The above and related experiments will be described in detail later elsewhere. We are indebted to the Agricultural Research Council, the Royal Society, and the Chemical Society for grants in support of this work.

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[1] Harper, *J. Chem. Soc.*, 892 (1946).
[2] *J. Org. Chem.*, **10**, 114 (1945).
[3] *J. Org. Chem.*, **10**, 222 (1945).
[4] *C.R. Acad. Sci., Paris*, **198**, 1235 (1934).
[5] Schechter, Green and LaForge, *J. Amer. Chem. Soc.*, **71**, 1517 (1949).
[6] Campbell and Harper, *J. Chem. Soc.*, 283 (1945).
[7] *Chem. and Indust.*, 636 (1949).
[8] LaForge and Barthel, *J. Org. Chem.*, **12**, 199 (1947).

Dimensions and Intrinsic Viscosity of Coiled Chain Molecules in Solution

The dimensions of coiled chain molecules in solution can be measured by the method of light scattering developed by Debije[1], Zimm, Stein and Doty[2], and Zimm[3]. If, at the same time, the intrinsic viscosity and the molecular weight of the solute molecules are determined, an experimental relation can be established between these two quantities and molecular size, and a comparison can be made with the various theories of the viscosity of high polymer solutions.

Accordingly, measurements were made on four fractions of polystyrene and on four fractions of poly*iso*butylene. Molecular size and weight were determined by a procedure analogous to the one described by Zimm[3]. The size is expressed as R, the root mean square distance between the ends of the coil. The intrinsic viscosities (expressed in litre/gm.) were measured with an Ostwald viscometer. Experimental details will be published elsewhere.

By changing the solvent, R could be made to vary independently of the molecular weight: on passing from a good solvent to a bad one the size of the molecules decreases considerably, especially near the precipitation threshold.

Mol. wt.	Solvent	R (A.)	$\{\eta\}$ (litre/gm.)
	Polystyrene		
$0{\cdot}83 \times 10^6$	benzene	960	0·125
,,	benzene + 50% hexane	750	0·085
,,	benzene + 50% hexane	580	0·075
$2{\cdot}00 \times 10^6$	benzene	1580	0·246
,,	chloroform	1580	0·212
,,	ethyl acetate	1040	0·115
,,	benzene + 50% acetone	1120	0·150
$2{\cdot}28 \times 10^6$	benzene	1640	0·236
,,	benzene + 12·5% ethanol	1510	0·209
,,	benzene + 17·6% ethanol	1420	0·194
,,	benzene + 22·2% ethanol	1270	0·157
,,	benzene + 26·3% ethanol	1060	0·121
,,	benzene + 28·5% ethanol	870	0·101
,,	benzene + 50% hexane	1280	0·155
,,	benzene + 58% hexane	860	0·11
$7{\cdot}7 \times 10^6$	benzene	2900	0·82
,,	benzene + 50% hexane	2000	0·37
,,	benzene + 40% acetone	2300	0·45
	Polyisobutylene		
$0{\cdot}17 \times 10^6$	*n*-heptane	690	0·045
,,	*n*-heptane + 20% propanol	660	0·033
$0{\cdot}50 \times 10^6$	*n*-heptane	1010	0·117
,,	*n*-heptane + 10% propanol	960	0·099
,,	*n*-heptane + 20% propanol	870	0·085
$1{\cdot}2 \times 10^6$	*n*-heptane	1470	0·311
,,	*n*-heptane + 10% propanol	1320	0·250
,,	*n*-heptane + 20% propanol	1170	0·197
$1{\cdot}9 \times 10^6$	*n*-heptane	1860	0·450
,,	*n*-heptane + 10% propanol	1710	0·401
,,	*n*-heptane + 20% propanol	1320	0·230
,,	*n*-heptane + 14% ethanol	1460	0·294

The most remarkable feature of the experimental results (see table) is that $\{\eta\}$ is essentially a function of R only, that is, that molecules of different weight but of the same size have nearly the same intrinsic viscosity. This fact cannot be explained by a theory involving particles completely impermeable to the solvent, as in that case $\{\eta\}$ would be inversely proportional to the molecular weight for constant R. Complete permeability, on the other hand, is fairly satisfactory in the case of poly*iso*butylene, as it predicts that $\{\eta\}$ would be proportional to R^3, regardless of molecular weight, in reasonable accordance with experiment; but it does not agree with the relations found in the case of polystyrene, where the exponent of R for a given molecular weight appears to be smaller than 2 and to increase with molecular weight. A theory of the Brinkman–Debije type[4], supposing partial permeability, was tried; but here, too, the agreement was only qualitative and far from satisfactory.

Thus it appears that none of the existing theories is confirmed by experiment. It is hoped that measurements now in progress on other polymers may shed some light on this problem.

I wish to thank Mrs. G. Gavoret, who collaborated in part of this work, and Dr. M. Magat for his stimulating interest and guidance. Thanks are also due to the management of the Koninklijke/Shell-Laboratorium, Amsterdam, for sponsoring this research and for their permission to publish these results.

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Feb. 24.

[1] Debije, P., *J. Phys. and Coll. Chem.*, **51**, 18 (1947).
[2] Zimm, B. H., Stein, R. S., and Doty, P. M., *Polymer Bull.*, **1**, 90 (1945).
[3] Zimm, B. H., *J. Chem. Phys.*, **16**, 1093, 1099 (1948).
[4] Brinkman, H. C., *Proc. Kon. Ned. Acad.*, **50**, 618, 821 (1947). Debije, P., and Bueche, A. M., *J. Chem. Phys.*, **16**, 572 (1948).

A Method of Breaking Emulsions

During the last few months, five emulsions formed during extractions, and unbreakable by any of the usual methods, have been broken rapidly and completely by addition of a wetting agent under the conditions described elsewhere for breaking emulsions of sea-water in fuel oil[1]. In three cases, 'Teepol' was used, and in two, Turkey Red Oil. The emulsions were formed during ether extractions in all cases; but other solvents were also present.

The emulsifying agent appeared to be finely divided precipitate, coated, in one case, by tarry products and in another by waxy impurity. Finely divided inorganic material can be made into a most efficient emulsifying agent by addition of organic substance which is adsorbed upon it; for example, addition of a small amount of fatty acid to iron rust makes it a most dangerous emulsifier of water in turbine oils. Wetting agents, being more surface-active than such emulsifying agents, which act by differential wetting by the two liquid phases, displace them and the emulsion breaks. The proper dosage of wetting agent is that amount required to form its critical concentration in the aqueous phase. This will vary widely in emulsions formed by chance during organic preparations; but, as a guide, it may be laid down that not more than 1 per cent should ever be used; with excess, there is danger of re-emulsification of the non-aqueous phase in the aqueous one. It is obvious that no general claim can be made. The wetting agent could even make things worse by forming a complex with substances present. The success of the method was, however, so spectacular in the five different cases cited that it is felt that the method should be a boon to organic chemists embarrassed by emulsions. A small test should be tried first. Moderate heating accelerates breaking.

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[1] Lawrence, A. S. C., *Chem. and Indust.*, 615 (1948). Lawrence, A. S. C., and Killner, W., *J. Inst. Petroleum*, **34**, 821 (1948).

Surface Effect and Structure of Single Crystal Wires

Some months ago, Mr. R. F. Y. Randall and I[1] reported on the effect of certain electrolytes, applied at the surface, on the flow of cadmium single crystals. We recorded that the immersion in solutions of cadmium sulphate and chloride, and particularly in commercial plating solution, led at once to a permanent increase in the rate of flow of single-crystal cadmium wires which were under stress, while cadmium nitrate solutions caused an immediate increase of rate followed by a decrease and final cessation of flow, a hardening effect which we attributed to the formation of a surface film, probably of oxide.

Since then, as surface effects were clearly involved, we have been working with single crystal wires which have been heated *in vacuo* under conditions that allow free evaporation, with consequent formation of a really clean surface. With such wires cadmium sulphate and chloride solutions have no effect on the

flow; but cadmium nitrate solution produces the same hardening as before. It would therefore appear that the effects reported earlier are due to very thin surface films, probably of oxide, which are attacked by the active electrolytes. We have long known, from work carried out in this Laboratory by Roscoe[2], that very thin oxide films both increase the critical shear stress and diminish the rate of flow under a given stress. Recently, Mr. Cyril Henderson, working here, has found that single crystals of silver which have been cleaned by surface evaporation and have been subsequently kept and tested in an inert gas show enhanced flow properties as compared to similar crystals which have been exposed to air, although the latter crystals show a bright, apparently clean, surface. It is, then, established in diverse ways that surface films, even when very thin, have a marked effect on the plastic properties of metal single crystals. We have failed to find any such effect with polycrystalline metals.

Mr. E. O. Hall has recently written to me to say that experiments on which he is engaged have convinced him that the effects which Randall and I discussed are due to the cracking open of oxide films on immersion in an ionic solution and that he has actually established the formation of these cracks microscopically.

I may add that heavy thermal evaporation from the surface of cadmium single crystals leaves narrow bright surfaces (about 0·05 mm. wide) of certain crystal planes, notably the basal planes. Optical reflexion from these has enabled Randall and me to show that slight variations in angle (of the order of 1°) exist between planes that in an ideal crystal should be parallel, as has been often suspected. We hope shortly to publish some quantitative results. Silver shows similar exposure of selected crystal planes with mirror reflexion.

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[1] Andrade, E. N. da C., and Randall, R. F. Y., *Nature*, **162**, 890 (1948).
[2] Roscoe, R., *Phil. Mag.*, **21**, 399 (1936).

Effect of Small Quantities of Hydrogen and Grain-Size on the α–β Transformation of Titanium

Since the publication of a note on the "Allotropic Transformation in Titanium" (*Nature*, July 2, p. 24), results have been obtained which throw further light on the transformation of titanium metal.

The sample of titanium used in obtaining the results previously reported had a very fine-grained structure. A thermal analysis curve on this sample showed two arrest points, at 860° and 900° C. The resistance-temperature curve also showed discontinuities at these temperatures. On removal of the small quantity of hydrogen present in the metal, the two transformation points merged into a single transformation at 882 ± 3° C., with a latent heat of transformation equal to the sum of the latent heats found for the double transformation.

On repeating a hydrogen equilibrium-pressure determination on a coarse-grained sample of titanium, again containing 0·02 atomic per cent hydrogen, an almost isothermal change in the equilibrium pressure occurred at 882 ± 3° C. The discontinuous change in hydrogen pressure at the transformation temperature is due presumably to a difference in the solubility of hydrogen in α- and β-titanium at this temperature. Thermal analysis and resistance-temperature curves for this coarse-grained titanium showed single discontinuities for metal containing 0·02 atomic per cent hydrogen, and no change was detected when the hydrogen was removed. The α–β transformation in coarse-grained titanium appears, therefore, to be quite normal.

It has been shown[1] that very small quantities of hydrogen in low-carbon steels have the effect of doubling the thermal-arrest points for the A_1- and A_3-transformations in these alloys. It may be that the results obtained for fine-grained titanium and those reported by Esser and Cornelius are due to a similar effect, and that the magnitude of this effect is related to the grain-size of the material.

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[1] Esser, H., and Cornelius, H., *Stahl u. Eisen*, **53**, 885 (1933).

Colour Changes Induced in Molybdenum and Tungsten Oxides under Flame Impact

While it is generally recognized that atoms and free radicals play an all important part in combustion reactions, simple direct demonstration of the presence of a definite species is often rather difficult. The experiments described below, which record a few simple observations on the reduction of molybdenum and tungsten oxides (MoO_3 and WO_3) at the edges of flames, appear to provide visual evidence of the presence of hydrogen atoms in flames, and also give an indication of their relative concentrations in different flames.

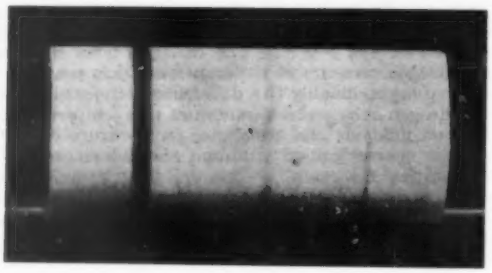
It is known from other work[1,2] that white molybdenum oxide is turned blue by hydrogen atoms, reduction to a lower oxide (written $MoO_3.Mo_2O_5.xH_2O$) taking place.

In the present experiments, molybdenum oxide (deposited on a 'Pyrex' surface by Johnson's method[1]) and tungsten oxide (used as a thin layer on a copper block) were exposed to the edges of several gas flames with the following results:

(*a*) Hydrogen diffusion flame: both oxides were strongly blued by brief contact with the edge of the flame. With thin deposits of molybdenum oxide, the blue colour was seen to fade gradually on exposure to air.

(*b*) Coal gas flames: with the luminous flame, both oxides were turned pale blue. With an aerated flame, the rate of blueing was considerably increased with both oxides and seemed to be greatest when the flame was about to strike back.

(*c*) Carbon monoxide diffusion flames: with both oxides a very faint blueing was observed at the edge of the outer mantle. With moistened carbon monoxide, the colour was more strongly developed.



The accompanying photograph shows a molybdenum oxide surface (deposited on a 'Pyrex' tube) which was exposed for similar times to the edges of small flames (*c.* 1 cm. high) of hydrogen, luminous coal-gas and moistened carbon monoxide (left to right). The rates of blueing clearly decreased in this order: hydrogen > coal gas > carbon monoxide.

In view of the earlier work on the reduction of molybdenum oxide by hydrogen atoms, it is likely that the intensity of the blue colour bears relation to the hydrogen atom concentration in the edges of the above flames. Moreover, the positive result obtained by moistening the carbon monoxide is in accord with the observation[3] that the total hydrogen concentration at points in a carbon monoxide flame, as measured by a palladium tube technique, is increased by addition of moisture to the gases fed to the flame.

It is instructive to compare the above observations with those of E. C. W. Smith[4,5], who has shown that the remarkable candoluminescent effects produced by impact of hydrogen-containing flames with calcium oxide surfaces promoted by certain oxides (for example, Sb_2O_3, MnO and Bi_2O_3) have their origin in the reaction $H + H \rightarrow H_2 + 103$ kcal., which occurs on the solid surface. Smith found that the intensity of the luminescence decreased in the order hydrogen > coal gas > carbon monoxide (no visible luminescence). It seems that the negative result found with carbon monoxide flames is presumably an effect of low hydrogen atom concentration, and that the molybdenum oxide experiments provide some evidence for these atoms in carbon monoxide flames. Certain reservations might have to be made, however, if the blueing experiments were assigned a more quantitative significance. For example, in view of the easy reversibility of the system

molybdenum trioxide $\rightleftarrows$ molybdenum blue,

the presence of other oxidizing agents (for example, oxygen and hydroxyl) and reducing agents (hydrogen, carbon monoxide, atomic oxygen) might complicate the issue. Whereas hydrogen and carbon monoxide appear to reduce MoO_3 to MoO_2 (brown) and molybdenum (greyish white), Rodebush and Nichols[6] state that atomic oxygen produced in a discharge effected *reduction* to molybdenum blue. However, available evidence[7] suggests that the atomic oxygen concentration in hydrogen flames is much smaller than in carbon monoxide flames, and that in the latter, moisture has little effect on the estimated atomic oxygen concentration. This provides a measure of support for the view that the development of blue colour at the flame edges was mainly due to atomic hydrogen.

These observations may be of value in considering the role to be assigned to hydrogen atoms in theories of flame propagation[8].

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[1] Johnson, T. H., *J. Franklin Inst.*, **206**, 301 (1928); **207**, 629 (1929).
[2] Robb, J. C., and Melville, H. W., *Trans. Farad. Soc.*, "The Labile Molecule", 132 (1947).
[3] Arthur, J. R., and Sterling, E., *Nature*, **160**, 869 (1947).
[4] Smith, E. C. W., Second Arthur Duckham Research Fellowship Report, Institution of Gas Engineers (1940).
[5] Townend, D. T. A., Jubilee Memorial Lecture, Society of Chemical Industry, *Chem. and Indust.*, **23**, 346 (1945).
[6] Rodebush, W. H., and Nichols, W. A., *Phys. Rev.*, **35**, 649 (1930).
[7] For example, Gaydon, A. G., *Proc. Roy. Soc.*, A, **183**, 111 (1944).
[8] For example, Tanford, C., and Pease, R. N., *J. Chem. Phys.*, **15**, 431 (1947).

Absence of Angular Correlation between β- and γ-Rays in Allowed β-Transitions

If a nucleus is formed by an allowed β-transition in an excited state and emits thereafter γ-radiation, there should be no correlation between the direction of emission of β- and γ-rays[1,2]. An experimental confirmation of this absence of correlation is of interest for both theoretical and practical reasons. On one hand, indication of the fact that a β-transition is of the allowed type ($\Delta j = 0, \pm 1$; $\Delta L = 0$) has so far only been obtained by a careful examination of the low-energy part of the Fermi plot, which is experimentally very difficult. The direct evidence that no change of orbital momentum is associated with such a β-transition is therefore desirable.

On the other hand, the absolute standardization of γ-ray sources has recently made considerable progress, thanks to the method suggested by Dunworth[3] and also by Rotblat[4]. This method necessitates the determination of the number of β-γ-coincidences and of the number of single counts obtained in a pair of counters, one of which is sensitive to β-rays and the other to γ-rays. Under these conditions it is an advantage to be able to rely on an absence of correlation in the angular distribution of β- and γ-rays.

The absence of an angular correlation is only a proof that there is no change of orbital momentum in the β-transition when it is already established that the excited nucleus formed in the β-transition has an angular momentum different from zero. This latter fact has been established for cobalt-60 and sodium-24, where the β-emission is followed by two γ-rays in cascade; the measurements of Brady and Deutsch[5] have shown that the disintegrations are of the 4.2.0 type.

We have investigated angular correlations in the following arrangement. A thin source of approximately 1 mgm./sq. cm., mounted on a disk of thin aluminium foil was set up on the axis of a turntable. A photomultiplier tube (E.M.I. type *VX*.5031), fixed at the circumference of this table, was fitted with a naphthalene crystal[6] giving a γ-ray efficiency of about 10 per cent. This crystal was housed in a 1·5-mm. lead cap to reduce the intensity of the γ-photons scattered out from the crystal and to shield the crystal from the β-rays. A second photomultiplier of the same type, fixed on the rotating arm of the turntable, was fitted with a 2-mm. thick

naphthalene crystal to detect the β-rays with low γ-ray efficiency.

For sodium-24, the β-ray crystal was mounted 8 cm. distant from the photomultiplier in a thin, polished silver tube so as to reduce the effect of γ-rays scattered from the bulk of the material in the vicinity of the photomultiplier. However, this procedure could not be followed when using cobalt-60 due to the loss of light (about 50 per cent) in the silver tube, and it was necessary to mount the source inside the photomultiplier housing. Under these conditions, the angles subtended by the crystals at the source was about $\pm 15°$.

With this geometrical arrangement and using a coincidence set with $1\frac{1}{2}$ μsec. resolving time, no angular correlation between the β- and γ-rays was found within the limits of experimental error.

The results obtained for $I(\pi)/I\left(\frac{\pi}{2}\right)$, where $I(\theta)$ is the coincidence-rate with an angular separation θ, were :

Na^{24}	$0{\cdot}99 \pm 0{\cdot}019$
Co^{60}	$1{\cdot}00 \pm 0{\cdot}025$.

The influence of correlation between the two γ-rays would be to make the above ratio 1·003 for sodium-24 and 1·01 for cobalt-60, the difference being due to the lower detectability of the β-rays from cobalt-60.

We wish to express our gratitude to Dr. J. D. McGee, of Electrical and Musical Industries, Limited, for the loan of the photomultiplier tubes, and to Lord Cherwell for extending to us the facilities of the Clarendon Laboratory.

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[1] Falkoff, D. L., and Uhlenbeck, G. E., *Phys. Rev.*, **73**, 649 (1948).
[2] Hamilton, D. R., *Phys. Rev.*, **60**, 168 (1941).
[3] Dunworth, J. V., *Rev. Sci. Instr.*, **11**, 167 (1940).
[4] Private communication.
[5] Brady, E. L., and Deutsch, M., *Phys. Rev.*, **74**, 1541 (1948).
[6] Kallmann, H., *Natur and Teknik* (July 1947).

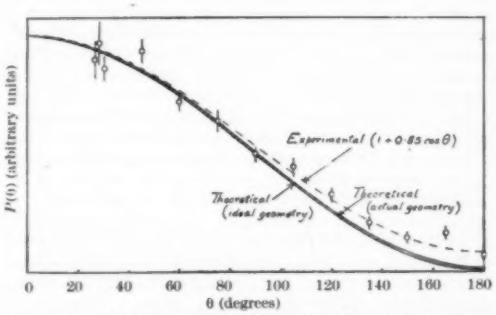
Electron Pair Creation by a Spherically Symmetrical Field

In the nuclear reaction $F^{19}(p,\alpha)O^{16}$, the oxygen nucleus can be produced in an excited state with an excitation energy of 5·9 MeV. The transition from this state to the ground state of O^{16} does not occur, as normally, by the emission of γ-radiation, but by the creation of electron-positron pairs[1], this fact being interpreted as meaning that its excited state has zero total angular momentum (J), and since its ground state also has zero J, a single γ-radiation transition between the two states is impossible[2]. Alternative, competitive processes such as emission of two quanta or a two-step transition via a state of oxygen-16 intermediate between the ground state and that at 5·9 MeV. have not been observed; the absence of the latter possibility is consistent with the absence of any evidence for an excited state of O^{16} below 5·9 MeV.

The nature of this electron-positron pair transition would be very different according as one assumes the parities of the two O^{16} states to be the same or different[2]. In the former case, the transition is essentially electromagnetic in nature, and the nucleus can be treated, in a correspondence principle type of argument, as a spherically symmetrical charge distribution with a density varying with time, and the resultant time-variable field can interact with the electrons in the negative energy states. In the latter case no interaction of an electromagnetic nature is possible, and the transition would have to be attributed to a specific interaction between electrons and the nucleus. On the assumption that the transition is of the former type, that is, both O^{16} states have $J = 0$ and even parity, one can calculate, from Dirac's electron theory, the angular correlation of positive and negative members of a pair. This result, which is independent of the absolute probability for the transition or the detailed description of the two O^{16} states, is[3]

$$P(\theta, E_+)d\theta\, dE_+ = A p_+ p_- (E_+E_- + p_+p_- \cos\theta - m_0^2) \frac{dE_+}{dE_+} \sin\theta\, d\theta, \quad (1)$$

where θ is the angle between the two members of the pair, with energies E_+ and momenta p_+ (units with velocity of light $c = 1$) and m_0 is the rest mass of electron. A is a constant independent of θ and E_+. In expression (1) applied to the case $E_+ \gg m_0$, the angular correlation is almost independent of the partition of energy between the electrons (E_+) over most of the range, so that it is easy to integrate (1) with adequate accuracy to obtain $P(\theta)$ averaged over all energies.



Angular correlation between directions of positron and electron

We have measured this average correlation, using the technique of counter arrays in coincidence, and our results are shown in the accompanying graph. The two solid curves show the theoretically predicted correlation : (*a*) for ideal geometry ; and (*b*) with adjustment for the actual geometry with finite angular resolution. Both curves (*a*), (*b*) are of the form $\alpha + \beta\cos\theta$, so that we have drawn (dotted curve) the best fit, using a function of this type, to the experimental points and normalized all three curves to the same value at $\theta = 0$. The general agreement between theory and experiment is good, although there seem to be substantially more pairs than predicted with $\theta > 90°$. Special care was taken to avoid spurious correlations (for example, from scattering or from detection of two-quanta annihilation of positrons), and several counter arrangements were used ; in all cases the discrepancy with theory was in the same direction as indicated in the graph. Since the discrepancy is only small, and in a region where there are substantial experimental corrections to be applied, it may well be due to unsuspected sources of error. The theory of pair creation, on the

other hand, can be applied to this phenomenon in a straightforward fashion and with only very minor approximations.

A fuller account of these experiments will be published elsewhere.

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[1] Streib, J. F., Fowler, W. A., and Lauritsen, C. C., *Phys. Rev.*, **59**, 253 (1941).
[2] Oppenheimer, J. R., and Schwinger, J. S., *Phys. Rev.*, **56**, 1066 (1939).
[3] Oppenheimer, J. R., *Phys. Rev.*, **60**, 964 (1941).

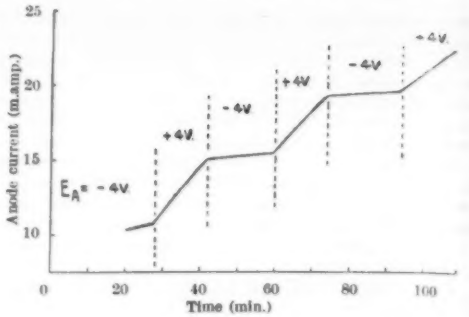
Reversibility of Oxygen Poisoning in Oxide-Cathode Valves

The subject of reversible oxygen poisoning in oxide cathode valves has received considerable attention in these laboratories during the past two years as we believe that it is connected, directly or indirectly, with the irreversible 'ageing' deterioration of such valves. New facts concerning reversibility have emerged, and some of these may interest workers in this field.

The cathodes studied were of the common stochiometric co-precipitated barium–strontium carbonate type, activated in the usual manner. The cathodes were built up as low-voltage diode structures and included, together with an oxygen generator, in a sealed envelope pumped to a vacuum of approximately $1{\cdot}0 \times 10^{-5}$ mm. mercury. The oxygen generator was either a heater wire covered with barium peroxide or an auxiliary surface covered with a film of barium oxide and arranged for bombardment by 8-volt electrons. The methods give a fine control over the rate and amount of oxygen generated.

The first problem studied was the degree of recovery from a fairly sharp attack of poisoning. A cathode was run at 1,000° K. for many hours as a space-charge diode passing approximately 20 m.amp. of current per sq. cm. From time to time the temperature of the cathode was lowered to 700° K. and a measurement of total emission made. (Great care was taken to ensure that these measurements of total emission were always taken at the same reduced temperature.) When the cathode had become stabilized, it was subjected at 1,000° K. to a stream of oxygen just sufficient to reduce the space-charge current by 90 per cent. The oxygen was then cut off and the diode allowed to recover at 1,000° K. The space-charge current recovery characteristic at 1,000° K. was recorded continuously, and the total emission at low temperature measured at appropriate intervals. Recovery was allowed to continue until no further increase in total emission was observed. The cycle of operation was then repeated. Results showed that, within the limits of experimental error, the reversal was complete over each of three cycles, and the total emission recovered its initial value after three successive attacks of oxygen poison sufficient to reduce emission by more than 90 per cent.

An attempt was next made to examine the nature of the recovery phenomenon. A diode with cathode at 1,000° K. and anode voltage of 4·0 volts was arranged in such a way that the polarity of the anode potential could be reversed instantaneously. The original space-charge current was 25 m.amp., and this



was reduced to 4 m.amp. by a burst of oxygen poisoning. The diode was then allowed to recover over a contiguous series of equal time periods during which the anode voltage was alternately + 4·0 volts and − 4·0 volts. The space-charge state during the negative anode voltage condition was measured by instantaneously switching to the positive voltage condition, recording the space-charge current, and switching back to the normal negative voltage condition. It was observed that recovery was rapid while current was passing through the cathode and much slower during periods of no current flow (see graph).

The phenomenon is explained in the following manner. After the oxygen atoms or molecules have entered the cathode, they become negatively ionized and tend to emerge from the cathode as negative ions. They are assisted in this emergence by the favourable potential gradient set up by the passage of a cathode current.

An alternative explanation to the dependence of recovery-rate on the magnitude of current flow might be sought in electrolysis. This possibility seems to be ruled out, however, by numerous experiments in which recovery was effected at temperatures ranging from 900° K. to 1,000° K. without any cathode current flow whatever. Current flow appears to effect only the rate of recovery.

Since emission from the cathode depends upon the relative rates of poisoning and reactivation, it follows that a cathode will be more resistant to poisoning at higher current densities. This idea was examined in the following manner. A low-voltage diode was set up with cathode at 1,000° K. and drawing 1 m.amp. to an anode. When the current was quite steady, a slow but continuous stream of oxygen was liberated in the valve. The current fell at a slow and constant rate under the poisoning attack. The space charge was then changed to 5 m.amp., and the cathode showed a reactivation effect in that the current slowly increased. Return to the lower current density brought back the poisoning reaction.

One final point may be made concerning the evolution of gas from a recovering cathode. Experiments carried out with such cathodes in triode structures showed that the gas pressure increased during the recovery stage and reached a steady maximum when the total emission of the cathode had ceased to rise. These measurements were made by the common reverse-grid-current technique.

The conclusion drawn from these results is that the passage of current through a cathode tends to accelerate the rate of ejection of the gas atoms which lead to reversible poisoning. It might also appear to follow that higher-density currents, resulting in higher potential gradients across the cathode, are

more favourable to cathode life than lower-density currents. This tentative conclusion assumes, of course, that deleterious ohmic heating of the cathode is not encountered, and that no spatial ionizing voltages exist across the cathode-anode space to cause the evolved gas to be driven back into the cathode as fast as it is evolved.

Results obtained by my colleague, Dr. S. Wagener, in an investigation of the influence of density of emission on the life of oxide cathodes[1], confirm these conclusions on a quantitative basis.

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Rheological Properties of High-Viscosity Solutions of Long Molecules

UNDER the above heading, we presented a note in *Nature*[1] in which we directed attention to certain peculiar phenomena observed with concentrated solutions of rubber or of aluminium soaps in hydrocarbons and gave an explanation. These phenomena concerned secondary flows, high inlet losses for flow in pipes, existence of 'retardation layers' with flow in small-diameter pipes and an increase in the surface energies of these systems when they are strained. It was noticed that the free energy of these systems increased on straining. Due to absence of experimental data, this increase in free energy was ascribed to a decrease in entropy, in analogy with the kinetic theory of rubber elasticity.

Experimental observation performed since this previous note has shown that the free energy does increase measurably and in a fairly reproducible manner on straining these systems. However, unlike rubber—which has a constant internal energy and a decrease in entropy with straining—these systems show increases both in the internal energy and the entropy. Thus, the previous conclusions remain valid except for these basic amendments in the *mechanism* of the occurrence of the phenomena.

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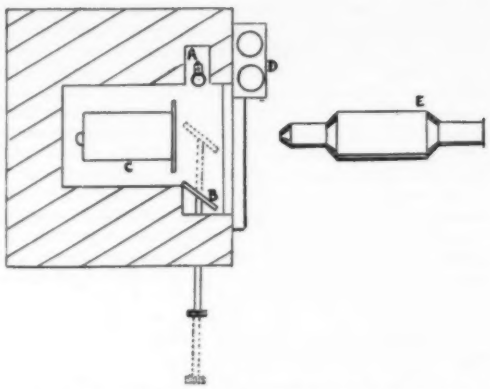
[1] Garner, F. H., and Nissan, A. H., *Nature*, **158**, 634 (1945).

Use of Geiger Counter for Quantitative Estimation of Phosphorus-32 in Histological Sections

IN a recent communication[1] details were given of a method for the quantitative estimation of radioactive isotopes in histological sections. A similar piece of apparatus was made by me some time ago for investigating the distribution of phosphorus-32 in sections of human enamel. In order to determine exactly what portion of the enamel was over the scanning hole, a low-voltage lamp and mirror were arranged inside the 'castle' to throw a beam of light out through the hole. The mirror was mounted on a



A, lamp; *B*, adjustable mirror; *C*, counting tube; *D*, mechanical stage; *E*, microscope

sliding rod, so that it could be pulled to one side of the counting tube. A microscope was arranged horizontally to view the scanning hole and the specimen; the general arrangement is shown in the diagram.

The scanning holes must be made with great accuracy, and the piercing of sheets with a needle is not recommended as the holes so produced tend to be conical and also not at right-angles to the surface of the metal sheet. Holes for my apparatus were made by clamping the lead or copper sheet between two plates of mild steel and drilling with a sensitive drill; suitable drills are found in the letter sizes or in Bridge's drills.

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[1] Bourne, G. H., *Nature*, **163**, 923 (1949).

Transpiration into a Saturated Atmosphere

IN a paper published in 1949, Dixon and Barlee[1] provided evidence of activated absorption of water by cut shoots, the leaves of which are in a saturated atmosphere or submerged in water, which does not appear to be open to the objections raised by Smith, Dustman and Shull[2] to Dixon's earlier experiments[3]. The fact that an atmosphere of nitrogen brings such absorption to an end, in some cases reversibly, shows that neither a residual water deficit nor transpiration from the leaves attributable to small temperature differences (due to absorption of light by the leaves) can account for the absorption observed when oxygen is available. It is nevertheless difficult to conceive a mechanism whereby transpiration into a saturated atmosphere could be maintained.

If the walls of the mesophyll cells abutting on the air spaces are to be regarded as permeable to water, root pressure or any other mechanism for increasing the turgor pressure beyond the saturation point would result in exudation of water on to the surface of the cells. Exudation activated by an electrosmotic potential difference would have the same result. In neither case should the vapour tension be greater than that at a free water surface; evaporation should therefore not occur, and the air spaces should become injected.

A greater vapour tension could, however, occur over a convex meniscus, maintained by pressure

from below at the orifice of a capillary the end of which is unwettable. The possibility of a mechanism embodying this principle is suggested by Lewis's observation[4] that the surface of mesophyll cells abutting on air spaces is unwettable. If the unwettable surface were finely porous, water exuding through the cell wall under an internal pressure would form convex menisci at the pores in the unwettable film and the air spaces would be kept supersaturated.

A further consequence of this condition would follow, namely, that an excess pressure, varying inversely with the size of the pores, would be required to flood the air-spaces with water—an obvious advantage to plants with no provision for guttation.

D. THODAY

Department of Botany,
University College of North Wales,
Bangor.
April 12.

[1] *Sci. Proc. Roy. Dublin Soc.*, **22**, No. 20 (1940).
[2] *Bot. Gaz.*, **91**, 395 (1931).
[3] Notes from the Bot. School, Trin. Coll., Dublin, **1**, 106 (1898); **4**, 319 (1938).
[4] Discussions of the Faraday Soc., No. 3, 159 (1948).

Production of Spring Wood with β-Indole Acetic Acid (Heteroauxin)

DURING an investigation of the development of annual rings in trees, a few crystals of heteroauxin were placed in a 3/16-in. hole bored in a white pine (*Pinus strobus* L.) branch on June 30. The hole was sealed with a beeswax–'Vaseline' mixture. A comparable check branch on the same tree was bored and sealed, but with no heteroauxin inserted. These branches were cut on September 11.

Four pieces about ¼ in. long were cut from the treated and untreated stems, just above the bored hole. These segments were treated with hydrofluoric acid for nine days, dehydrated with ethyl alcohol and embedded in celloidin according to Wetmore's method[1]. Transverse sections were cut with a sliding microtome and stained with iron hæmatoxylin and safranin[2].

The technique did not show the details of the cambium to advantage, because shrinkage had caused partial collapse of these thin-walled cells. However, the last two rows of tracheids in the treated material showed a marked difference as compared with the untreated material. They were much larger, thinner-walled, and resembled typical spring-wood tracheids which are normally formed earlier in the growing season. It was noted in the untreated control branch that the last tracheids to differentiate were summer-wood tracheids having a relatively narrow radial measurement, a thickened secondary wall and tangential pitting. However, a more complete investigation of the treated branch showed that the production of wide-lumened spring-wood tracheids did not extend all the way around the circumference of the annual ring. Rather, they were formed on each side of the wound with heteroauxin crystals, but had not formed in the quadrant directly opposite the wound. Additional experiments using a paste of lanolin and heteroauxin crystals showed that with concentrations higher than 20 mgm. heteroauxin per gm. of lanolin, transitional types of tracheids ranging from typical spring wood to typical redwood could be discerned. Wershing and Bailey[3] have already noted that redwood is formed with higher concentrations of heteroauxin in lanolin applied to the hypocotyls of pine seedlings.

Microchemical tests, using Ruthenium Red as an indicator, showed that while the cells are enlarging under the influence of heteroauxin, the middle lamella and primary wall remain in the form of 'plastic' pectic acid. However, untreated controls indicate that formation of 'non-plastic' calcium pectate from 'plastic' pectic acid takes place in the middle lamella and primary wall at a much earlier date than in the branches treated with heteroauxin. Further investigations, which may lead to a more complete understanding of annual ring development, are still in progress.

D. A. FRASER

Forest Insect Laboratory,
Sault Ste. Marie, Ont.
April 5.

[1] Wetmore, R. H., *Stain Tech.*, **7** (7), 37 (1932).
[2] Johansen, D. A., "Plant Microtechnique" (McGraw-Hill, N.Y., 1940).
[3] Wershing, A., and Bailey, I. W., *J. Forestry*, **40** (1942).

Occurrence of *Falkenbergia* on the English Coast

ON April 17, 1949, during the course of a survey of the shore known as the Gates at the southern tip of Lundy, a piece of a Floridean alga, too small to identify with certainty, was collected in order that its population of epiphytic red algæ might be examined. It occurred in a pool very near extreme low water springs, the spring tides at this period being some of the biggest of the year.

On examination of the sample in the field laboratory it proved to include plants of *Antithamnionella sarniensis* Lyle, *Ceramium* sp. and a filamentous alga having something of the appearance of a *Polysiphonia*, but not according with any species known to the collector (C. C. H.). It was therefore preserved and submitted, through the kindly agency of Mr. Owen Gilbert, to Dr. K. M. Drew.

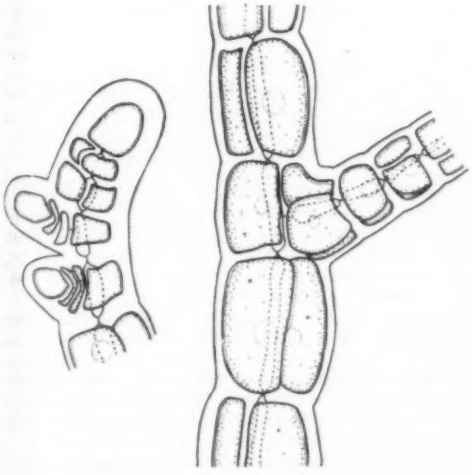
This *Polysiphonia*-like alga (Fig. 1) is undoubtedly a species of *Falkenbergia*, and, so far as we know, this is the first record of its occurrence along the coasts of the British Isles apart from the Channel Islands. *Falkenbergia* is readily distinguishable from *Polysiphonia* by the presence of three pericentral cells only around each cell of the central filaments as well as by the formation of lateral branches direct from the pericentral cells, trichoblasts being absent (Fig. 2). Each pericentral cell may cut off a gland cell from its internal face; but these are not so easily seen in preserved material. The macroscopic appearance of the Lundy specimen suggests a young growth of *Trailliella intricata* or *Spermothamnion Turneri*, from both of which, however, it is readily distinguishable by means of a hand lens.

Falkenbergia is a genus claiming particular interest for two reasons: first, one or more species appear to be enlarging their area of distribution fairly rapidly, and secondly, J. Feldmann and G. Feldmann[1] consider that *Falkenbergia rufolanosa* develops from the carpospores of *Asparagopsis armata* and is the tetrasporophyte of that alga.

Five species of *Falkenbergia* have been described; but the Feldmanns consider that no satisfactory criteria exist for distinguishing four of these species from each other. The fifth species, *F. vagabunda* (Harv.) Falk., described from Australia, is still im-

Fig. 1. Photograph of terminal branch-systems of *Falkenbergia*. (× 60)

perfectly known, but shows considerable resemblance to the other four. However, if a *Falkenbergia*-phase occurs in the life-history of the various species of *Asparagopsis*, there must be more than one 'species' of *Falkenbergia*, even if they are not easily distinguishable. On the grounds of distribution, it would seem likely that the 'species' found at Lundy is the same which was described originally from Australia as *F. rufolanosa* (Harv.) Schmitz, records[1] of the appearance of which along the coasts of North Africa and the Iberian Peninsula, as well as the Atlantic and Mediterranean coasts of France, have been made at intervals since 1923. It occurs also in Japanese waters, the Malayan Seas, the Indian Ocean, the Arabian Sea and the Red Sea.



(*a*) (*b*)

Fig. 2. (*a*) Apex of branch showing development of two lateral branches; (*b*) insertion of fully developed branch on main axis. (× 1,500)

It is hoped that others interested in marine ecology will keep a watch for this alga around the British coasts, together with *Asparagopsis armata*, the spread of which has been so closely parallel to that of *F. rufolanosa*, as is to be expected if they are both phases in the life-history of one organism. The *Falkenbergia*-phase is reported to bear tetrasporangia. These have been found in December at Nice and Guéthary in France and Cherchell in Algeria as well as in January at Rabat in Morocco. The specimen on which this record is based is sterile, and judging from previous records this is frequently the case. Further observations on the tetrasporangia are very desirable, and collections at some other time of year may prove to be fertile.

C. C. Harvey
University College of the South West,
Exeter.

Kathleen M. Drew
Department of Cryptogamic Botany,
University, Manchester.
July 28.

[1] Feldmann, J., and Feldmann, G., *Ann. Sci. Nat., Bot.*, **11**, 3, 75 (1942).

Germination of Zygospores in *Chlamydomonas*

Studies on the life-cycles of green algae have frequently been considerably hampered by the difficulty of obtaining germination of the zygospores. This obstacle was encountered here during preliminary investigations to determine the possibility of using, for genetic studies, an isogamous, heterothallic strain of *Chlamydomonas Moewussi* Gerloff (isolated in 1948 from greenhouse sand by Drs. P. R. Furkholder and L. Provasoli). Mature zygospores, which are dark green, with verrucose walls, remain dormant for an indefinite time, and only a low percentage of spontaneous germination is obtained after several weeks. Initially, no success in promoting germination was achieved by the use of a wide range of physical and chemical treatments. (Examples of treatments which have been successful in other algae are reviewed by Bold[1].)

It appeared possible that starvation of the zygotes, during the formative period following fertilization, might reduce the amount of stored metabolites or the thickness of the walls, and thus shorten the period of dormancy. This result was indeed obtained, almost 100 per cent germination following the treatment. Though the rationale has not been confirmed, the principle of the technique may be of general application, and details of the treatment are given. It is obvious that modifications will have to be introduced to adapt the method to other organisms.

Suspensions of gametes are mixed in light, and drops of the mating mixture transferred to the surface of 1 per cent agar containing mineral salts in the proportions given by Juller[2]. They are then illuminated for twenty-four hours (continuous fluorescent light, 470 f.c., at 25° C.), and afterwards transferred to darkness at 20° C. The walls of the developing zygotes remain thinner than those of fully light-grown spores, and within five to six days the contents begin to divide. At the end of a further five to six

days, virtually all the zygospores have produced four or eight zoospores.

The limits of the period of initial illumination, i, are set on one hand by the process of gamete fusion, which only proceeds in the light (no zygospores are formed unless i exceeds 14–18 hr.), and on the other by the formation of thick-walled 'resting' zygospores (which appear if i exceeds 26–30 hr.). Within these limits, it is found that lower values of i promote earlier germination, producing four zoospores; but the zygotes are smaller, and viability of the zoospores is reduced. Conversely, with increasing values of i (exceeding 22 hours), the proportion of zygotes producing eight zoospores increases from 0 per cent to as high as 95 per cent. For the purposes of tetrad analysis, four zoospores would usually be preferable.

If, during the period of darkness, the zygotes are subjected to higher temperatures (25° or 30° C.), germination is delayed; but otherwise the course of events is similar to that outlined above.

The 'breaking' of dormancy, however, has not been achieved. Zygospores matured in continuous light for three days or longer have so far resisted all attempts to induce regular germination.

Investigations on *Chlamydomonas* are being carried out during tenure of a Sheffield fellowship.

RALPH A. LEWIN

Osborn Botanical Laboratory,
Yale University,
New Haven, Conn.
April 21.

[1] Bold, H. C., *Bot. Rev.*, **8**, 109 (1942).
[2] Juller, E., *Arch. f. Protistenk.*, **89**, 61 (1937).

Effect of Ethyl Alcohol and Carbon Dioxide on the Sporulation of Bakers' Yeast

THE sporulation of a strain of *Saccharomyces cerevisiæ*, carefully maintained true to type as a commercial baking yeast, has varied in 5–50 per cent of the cells under apparently the same conditions; namely, on slants of 'Difco' nutrient agar at *p*H 7·3 incubated for three days at 30° C. Investigation showed that if fermenting liquids happened to be in the same incubator, the ethyl alcohol and carbon dioxide formed by them had an adverse effect on sporulation, and this effect could be reproduced by the vapour from aqueous ethyl alcohol solutions, or by mixtures of carbon dioxide and air. In the case of aqueous alcohol vapour, the reduction in sporulation was accompanied by a marked increase in yeast growth due, presumably, to the utilization of alcohol as a source of carbon. Carbon dioxide and air mixtures, however, caused only a slight increase in yeast growth although sporulation was apparently inhibited.

It is therefore suggested that when spores are required, particularly in yeasts that do not sporulate readily, alcohol vapour and carbon dioxide should be avoided.

It is hoped to publish further details of this work and other facts relative to the sporulation of yeasts at a later date.

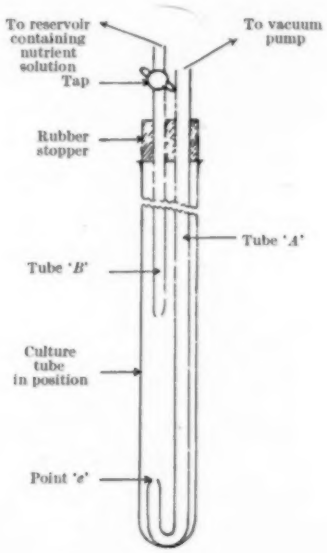
T. B. BRIGHT
P. A. DIXON
J. W. T. WHYMPER

The Distillers Company, Ltd.,
Research and Development Department,
Great Burgh, Epsom.
March 30.

Automatic Measuring Burette

INVESTIGATIONS on plant tissue culture methods in this laboratory have entailed the weekly use of several hundreds of standard culture tubes (150 mm. × 25 mm.) each charged with 10 c.c. of nutrient solution. In view of the large number of tubes in use, need was felt for a rapid and accurate means of charging them with the required volume of liquid. With this in mind the following simple apparatus was designed.

The essential part of the apparatus is a glass tube, *A* (see diagram), of internal diameter approximately 5 mm., the lower end of which is bent to form a U-tube: the end of the short arm, *e*, is drawn out to a point. The other end of tube *A* is connected to a vacuum pump. Tube *B* is connected to a reservoir containing nutrient solution, flow of which is controlled by a tap or clip. Both tubes are held in position by a rubber stopper, the position of which is so adjusted that, during filling, the lower surface of the U-tube rests on the bottom of the culture vessel. The whole assembly may be conveniently held in a retort-stand clamp.



The working principle of the apparatus is as follows: a culture tube is placed in position and liquid is run in via tube *B*; the level of the liquid rises until it reaches the top of the short arm *e*, when any surplus is drawn off via tube *A*. It is the height of *e* which predetermines the volume of liquid remaining in the culture tube (assuming a fairly high degree of uniformity in the culture vessels in use).

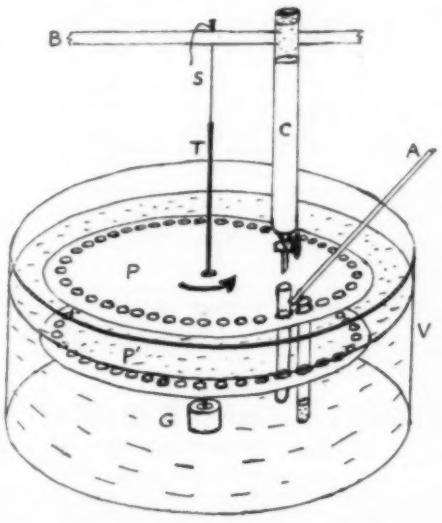
When calibrating the apparatus, due allowance must be made for the displacement volume of the U-tube. The required volume of liquid is first accurately measured out into the culture tube with a pipette; the U-tube assembly is then lowered into the liquid, the level of which is noted; finally, the short arm of the U-tube is cut to such a length that, when re-immersed, point *e* coincides with the surface of the liquid.

The apparatus can be adapted for use with a variety of culture vessels, and has a filling-capacity of three to four hundred per hour.

E. F. Collingwood
Department of Agricultural Botany,
King's College,
University of Durham,
Newcastle upon Tyne 1.
May 9.

A Simple Automatic Fraction-Cutter for Liquid Columns

With increasing use of chromatographic columns, the need has arisen for automatic fraction-cutting apparatus. Stein and Stanford Moore[1] have devised such an apparatus in which the fraction is measured photo-electrically and the battery of receivers then moved on by an electric motor. Randall and Martin[2] have recently described an ingenious mechanical fraction-cutter in which an intermittent siphon cuts the fractions. The weight of the fraction operates an escapement, bringing the siphon opposite the next receiver, the rack of receivers being stationary. In the apparatus described here, the receiver, which is depressed by the weight of the fraction, acts as the escapement. Randall and Martin used the torque of a twisted string to move the siphon delivery tube, and this idea has been copied here to move the whole rack of tubes.



In the diagram, two circular disks of thin aluminium PP' are drilled just within their peripheries with holes very slightly larger than the tubes it is intended to use, with the holes as close together as the drilling will permit. T is a 3-mm. screwed rod to which the disks are attached by nuts, and S is a string passing through a narrow hole in the fixed beam B. G is a small block of brass drilled so that the lower end of the axle T is kept loosely in position. C is the chromatographic column or other source of liquid to be fractionated. With the disks and rod hanging by the pegged string from the beam, and the lower end just retained by the guide G, the vessel V is filled with water until the level reaches the upper disk P. The thin, rimless test tubes are then inserted in the holes and should bob up and down freely when lightly touched, with practically no sideways movement. The string S is twisted, while the rack of tubes is prevented from turning by the light aluminium strip A. At the start, A lies between two of the tubes (a tube must be omitted to make room), the liquid drips into the tube which A is touching and which is directly under the column. As the liquid collects the tube sinks, and eventually, with the addition of a single drop, passes under the tip of A, the torque of the string then bringing the next tube under the column. It has been found advantageous to have a safety razor blade at the tip of A, mounted almost horizontally. Impact of the fresh tube against A can be made to jerk a recording pen. The tubes can be readily sorted beforehand by filling the rack and removing those which project far below or above the mean height. By altering the level of the tip of the strip A the fraction size can be altered. With sorted tubes the fraction size is not very variable. If the column is allowed to drip too rapidly, or the tubes are spaced too far apart, there is a risk of a drop of eluate falling between two of the tubes before a fresh tube has moved into position, and, moreover, the torque on S must not be too great or the friction of A against the tubes will prevent their descent.

D. M. P. Phillips
Courtauld Insfitute of Biochemistry,
Middlesex Hospital Medical School,
London, W.1.

[1] Stein, W. H., and Moore, Stanford, *J. Biol. Chem.*, **176**, 337 (1948).
[2] Randall, S. S., and Martin, A. J. P., *Biochem. J.*, **44**, *Proc.* ii (1949).

A Pressure-Cooked Non-Moulding Adhesive Flour Paste

The common boiled-flour adhesive paste has for laboratory and office use the disadvantages that (as often prepared) it is messy to make, difficult to get of uniform consistency, and falls easily a prey to moulds. The use of a common domestic pressure cooker has enabled me to work out a recipe the product of which appears to meet the three objections above.

75 gm. wheat flour and 1 gm. powdered alum are stirred into 500 c.c. of a 1/1,000 solution in water of mercury perchloride at room temperature. The resulting thin batter is put into an enamel basin and pressure-cooked for 10 min. The cooker is allowed to cool slowly, and opened when pressure has fallen. The cooked paste is briskly beaten with a fork while hot, which operation distributes any unevenness in consistency, and appears also, by aerating the mass, to give the cooled paste an attractive waxy appearance. A few drops of oil of cloves or of lavender are stirred into the mass when cool, for reasons which may be merely traditional.

I have found that this adhesive resists moulds even under tropical conditions; and it may be noted that since the mercury solution is the liquor hydrargyri perchlor. of the Pharmacopœia, the paste is not poisonous.

Lindsay Verrier
Vanua Levu,
Fiji.
March 23.

FORTHCOMING EVENTS

Monday, September 26—Wednesday, September 28

BRITISH RHEOLOGISTS' CLUB (at The University, Bristol).—General Conference and Annual General Meeting.

Monday, September 26

At 2.30 p.m. and 8 p.m.

Tuesday, September 27

At 10 a.m., 2.30 p.m. and 8 p.m.

Wednesday, September 28

At 10 a.m., 2.30 p.m. and 8 p.m.

Tuesday, September 27

ROYAL ANTHROPOLOGICAL INSTITUTE (at 21 Bedford Square, London, W.C.1), at 5 p.m.—Prof. Ralph Linton: "Recent Developments in the Study of Personality and Culture".

INSTITUTE OF SOCIOLOGY (joint meeting with the BRITISH SOCIETY FOR THE HISTORY OF SCIENCE, at the Royal Society, Burlington House, Piccadilly, London, W.1), at 5.30 p.m.—Mr. Humphry Trevelyan: "Goethe and Modern Thought", to be followed by a discussion which will be opened by Prof. William Rose.

Wednesday, September 28

PHYSICAL SOCIETY, COLOUR GROUP (in the Staff Common Room of the Imperial College Union, Prince Consort Road, London, S.W.7), at 3.30 p.m.—Dr. E. J. Stearns: "Current Activities of the Inter-Society Color Council".

Wednesday, September 28—Friday, September 30

SOCIETY OF CHEMICAL INDUSTRY, FOOD GROUP (in the William Beveridge Hall, The Senate House, University of London, London, W.C.1).—Symposium on "Amino Acids and Protein Hydrolysates".

Friday, September 30

ROYAL STATISTICAL SOCIETY, BIRMINGHAM GROUP OF INDUSTRIAL APPLICATIONS SECTION (in the Chamber of Commerce, 95 New Street, Birmingham), at 6.30 p.m.—Dr. J. Rodgers: "Statistics as an Aid to Productivity".

APPOINTMENTS VACANT

APPLICATIONS are invited for the following appointments on or before the dates mentioned:

BIOCHEMIST to the Reading Group of Hospitals—Chief Administrative Officer, 3 Craven Road, Reading, marking application "Appointment of Biochemist" (September 30).

ASSISTANT EXPERIMENTAL OFFICER IN MYCOLOGY, to be attached to the Plant Protective Chemistry Section—The Secretary, East Malling Research Station, Maidstone, Kent (October 3).

SENIOR ASSISTANT IN THE DEPARTMENT OF PHYSICS AND TELECOMMUNICATIONS—The Clerk to the Governors, Woolwich Polytechnic, Woolwich, London, S.E.18 (October 3).

TEACHERS OF PROFESSIONAL ENGINEERING in Post-Primary Schools in New Zealand—The Office of the High Commissioner for New Zealand, 415 Strand, London, W.C.2 (October 3).

MINING SURVEYOR (male) to take charge of the Mining Record Office, Buxton, under the Ministry of Fuel and Power—The Secretary, Civil Service Commission, Scientific Branch, 27 Grosvenor Square, London, W.1, quoting No. 2776 (October 6).

PRINCIPAL OF SHREWSBURY TECHNICAL COLLEGE—The Secretary for Education, Education Office, County Buildings, Shrewsbury (October 10).

LECTURER IN POULTRY HUSBANDRY at the Shropshire Farm Institute, Walford, near Baschurch—The Secretary for Education, County Buildings, Shrewsbury (October 11).

ADVISORY OFFICER IN GRASSLAND HUSBANDRY—The Secretary, West of Scotland Agricultural College, 6 Blythswood Square, Glasgow, C.2 (October 12).

INSPECTORS (Salmon and Freshwater Fisheries) in the Ministry of Agriculture and Fisheries—The Secretary, Civil Service Commission, 6 Burlington Gardens, London, W.1, quoting No. 2762 (October 13).

VETERINARY INSPECTORS, RESEARCH OFFICERS, and ASSISTANT VETERINARY INVESTIGATION OFFICERS, in the Ministry of Agriculture and Fisheries—The Secretary, Civil Service Commission, 6 Burlington Gardens, London, W.1, quoting No. 2779 (October 13).

READER IN SOCIAL ANTHROPOLOGY or READER IN COMPARATIVE SOCIAL INSTITUTIONS at the Research School of Pacific Studies, Australian National University, Canberra, A.C.T.—Administrative Officer of the University in the United Kingdom, 6 Gordon Square, London, W.C.1 (October 14).

RESEARCH OFFICER IN THE WOOL BIOLOGY LABORATORY, Division of Animal Health and Production, Commonwealth Scientific and Industrial Research Organisation, Sydney—Chief Scientific Liaison Officer, Australian Scientific Research Liaison Office, Africa House, Kingsway, London, W.C.2, quoting No. 1075 (October 15).

ENGINEER I (Ref. C.596/49AA) in charge of design and development of optical systems and small precision mechanisms, and ENGINEERS II and III (Ref. C.597/49AA) for the design of optical systems and small precision mechanisms, in a Ministry of Supply Establishment in Surrey—The Ministry of Labour and National Service, Technical and Scientific Register (K), York House, Kingsway, London, W.C.2, quoting the appropriate Ref. No. (October 15).

DIRECTOR OF RESEARCH AND DEVELOPMENT, Melbourne, and a DIRECTOR, LONG RANGE WEAPONS, Melbourne—The Australian Munitions Representative, Canberra House, 87 Jermyn Street, London, S.W.1 (October 15).

PRINCIPAL OF THE TECHNICAL COLLEGE OF THE GOLD COAST—The Director of Recruitment (Colonial Service), Colonial Office, Sanctuary Buildings, Great Smith Street, London, S.W.1, quoting No. 27054/71 (October 17).

EXPERIENCED ENGINEERS by the Ministry of Works (Heavy Research Plant Section) to supervise erection of large engineering plant and services for Government Research Establishments: Site Mechanical and Electrical Engineer (Ref. C.502/49AA), a Deputy Site Engineer (Ref. C.503/49AA), and a Sectional Site Engineer (Ref. C.504/49AA)—The Ministry of Labour and National Service, Technical and Scientific Register (K), York House, Kingsway, London, W.C.2, quoting the appropriate Ref. No. (October 24).

PROFESSOR OF ASTRONOMY, and a PROFESSOR OF GEOLOGY, in the Faculty of Science, Fouad I University, Cairo—The Director, Egyptian Education Bureau, 4 Chesterfield Gardens, London, W.1 (October 26).

LECTURER IN BIOLOGY (male or female)—The Dean, St. Bartholomew's Hospital Medical College, West Smithfield, London, E.C.1 (October 30).

RESEARCH OFFICER IN THE NATIONAL CHEMICAL RESEARCH LABORATORY in Pretoria—The Secretary-Treasurer, Council for Scientific and Industrial Research, P.O. Box 395, Pretoria, South Africa (November 25).

CIVIL ENGINEERS for design in Wellington on the new programme required for hydro-electric projects—The High Commissioner for New Zealand, 415 Strand, London, W.C.2 (November 30).

PROFESSOR AND HEAD OF THE DEPARTMENT, a PROFESSOR OF MECHANICAL ENGINEERING and a PROFESSOR OF HYDRAULIC ENGINEERING, for the Department of Power Engineering, a PROFESSOR OF BIOCHEMISTRY, and a PROFESSOR AND HEAD OF THE DEPARTMENT OF METALLURGY—The Registrar, Indian Institute of Science, Bangalore 3, India (December 15).

ASSISTANT CHEMIST at Stonebridge Park (London)—The Director of Research, Railway Executive, Euston Station, London, N.W.1.

BIOCHEMIST (honours graduate in Biochemistry, or honours degree in Chemistry with Biochemical experience) to assist in researches in the biochemistry of lactation—The Secretary, National Institute for Research in Dairying, Shinfield, Berkshire.

ENTOMOLOGIST and PLANT ECOLOGIST, for work with a team to carry out research on locusts in Cyprus, with special reference to the ecological factors affecting their distribution, fluctuation in numbers and densities and the formation of the swarming phase—The Under-Secretary of State, Colonial Office (Research Department), Sanctuary Buildings, Great Smith Street, London, S.W.1.

LECTURER IN ELECTRICAL ENGINEERING for the Chance Technical College—The Chief Education Officer, 215 High Street, Smethwick.

RADIO ENGINEER for appointment as Technical Author in the Air Technical Publications branch of the Ministry of Supply at Malvern, Worcs—Ministry of Labour and National Service, Technical and Scientific Register (K), York House, Kingsway, London, W.C.2, quoting D.316/49-A.

METEOROLOGISTS in the West African Meteorological Service—The Director of Recruitment (Colonial Service), Colonial Office, Sanctuary Buildings, Great Smith Street, London, S.W.1.

FIELD ZOOLOGIST, Tsetse Fly Survey and Control, Kenya Veterinary Department—The Director of Recruitment (Colonial Service), Colonial Office, Sanctuary Buildings, Great Smith Street, London, S.W.1.

CURATOR OF BOTANICAL SUPPLY UNIT—The Secretary to the Senate, University of London, Senate House, London, W.C.1.

GEOPHYSICIST to undertake geophysical surveys for the location of underground water by the electrical resistivity method, in Northern Rhodesia—The Director of Recruitment (Colonial Service), Colonial Office, Sanctuary Buildings, Great Smith Street, London, S.W.1, quoting No. 27079/43.

CANNING OFFICER (with a university honours degree in biochemistry with practical knowledge of bacteriology and the chemistry of preserved food) in the Department of Agriculture of the Federation of Malaya—The Director of Recruitment (Colonial Service), Colonial Office, Sanctuary Buildings, Great Smith Street, London, S.W.1.

REPORTS and other PUBLICATIONS

(not included in the monthly Books Supplement)

Great Britain and Ireland

Department of Scientific and Industrial Research. Report of the Pest Infestation Research Board for the Year 1947, with the Report of the Director of Pest Infestation Research covering the Years 1940–1947. Pp. iii+23. (London: H.M. Stationery Office, 1949.) 6d. net. [48

Editorial and Publishing Offices of "NATURE"
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